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Symposium on Colon Surgery

Introduction

THE papers and panel discussions which were presented by the members at the first annual meeting of the Association for Colon Surgery are published in this issue. The first meeting was held in Miami Beach, Florida on June 12, 1960.

A new society was organized by a host of general surgeons who are interested in the function and diseases of the intestinal tract. Contributors to several symposia on intestinal diseases that appeared in the Surgical Clinics of North America between the years of 1955 to 1959 and to the textbook, *Diseases of the Colon and Anorectum,* form the nucleus of this new Association. The idea for the formation of the new organization has found enthusiastic acceptance among surgeons throughout the country. The great preponderance of the charter members are associated with teaching institutions. Many of them have been engaged for years in important research problems relating to the alimentary tract.

When a new society is formed, there are always a few persons who believe that we already have enough surgical societies and that it would be impossible to obtain a sizeable audience or membership for an additional one. This may be true for a few hundred surgeons who already belong to several societies but, in general, the argument is fallacious because of the rapidly increasing number of well trained young surgeons entering the practice of surgery during the past ten or twenty years. It is very discouraging to scan the list of young surgeons denied membership in the surgical societies existing at the present time because of the limitations on membership. It is our belief that the membership limitations of the present societies cannot be enlarged at the present time because extension would produce inability to maintain the close contact so desirable and necessary for the optimum dividends obtainable from membership in a society. The American College of Surgeons is, of course, an exception and can still enlarge its membership, but the purpose of this organization is entirely different from that of the College. When the Central Surgical Association and the Society of University Surgeons were founded several years ago, they were criticized for the same reasons. However, their membership was filled long ago and each of these societies has been forced to decline membership to a large number of capable young surgeons.

The vast majority of young surgeons trained today is brought up in an academic atmosphere. Many of them are very anxious to belong to organizations which will help to provide an academic atmosphere for inquiry and an opportunity to present ideas of their own. It is unquestionably true that the development of societies or forums will allow opportunities for this expression and improve the scientific background and initiative of the young surgeon. From the standpoint of membership, the plan of this society is to increase rapidly the ratio of young surgeons in its membership in order to establish academic opportunities for young surgeons as well as the older group. It is also planned to invite physiologists, pathologists and other allied specialists to be members.

Accordingly, the main aims of this Associa-

tion are: (1) to create an experimental and clinical forum for intestinal surgeons, physiologists and pathologists so that they may pool their experience and knowledge; (2) to stimulate and foster interest and research not only in the function and diseases of the colon and rectum, but in the entire alimentary tract, and (3) to encourage adequate teaching of anorectocolonic function and diseases to medical students, interns and residents.

Not only will this Association encourage and promote research but it also plans to provide financial means to deserving and promising physicians in medical schools or other medical centers. No special journal is contemplated. The Proceedings will be published in a journal which is devoted to all the surgical specialties. This Association will abstain from strict specialization. The Association for Colon Surgery will work in harmony with the American College of Surgeons and the American Board of Surgery.

Minimum requirements for membership are: (1) Fellowship in the American College of Surgeons or the equivalent, and (2) demonstrated interest in intestinal problems as evidenced by published contributions in this field. At present, the membership will be limited to 250 active and twenty-five honorary members. The founder membership will remain open to qualified individuals until June 1962.

The next meeting of the Association will be held in New York, New York in June, 1961.

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Intestinal Antisepsis and the Spread of Tumors of the Colon

ISIDORE COHN, JR., M.D. AND M. ATIK, M.D., *New Orleans, Louisiana*

From the Department of Surgery, Louisiana State University School of Medicine, New Orleans, Louisiana. This study was supported by Grant No. E-1600 from the National Institute of Allergy and Infectious Diseases, National Institutes of Health, United States Public Health Service.

IN 1953 Vink [6] showed experimentally that intestinal antisepsis increased the incidence of tumor growth at an anastomotic site in the colon. The many obvious implications of such a study and of comparable clinical studies prompted us to repeat Vink's work with certain modifications.

It is now generally accepted that tumor transplantation can and does occur from the cut, free end of the bowel containing a cancer. Several workers in this country and in England have studied the incidence of tumor implantation in the suture line and in other areas in their own experience [1–5]. If intestinal antisepsis increases the incidence of this complication, as has been suggested by Vink's work, such knowledge is of the utmost importance to anyone interested in surgery of the colon in which such a complication is most likely to arise.

Vink's choice of the Brown-Pearce tumor in the rabbit probably was dictated by the ease with which this tumor can be used for this purpose and the relative rarity of tumors which can be used for the study of tumor growth in the gastrointestinal tract of larger animals. The same tumor was used in these experiments although the tumor was grown in the anterior chamber of the rabbit eye rather than in the testicle as advocated by Vink.

When the tumor was of sufficient size to fill the anterior chamber of the eye, it was removed. Portions of it were used for four different purposes. One portion was cultured to determine the bacterial flora being transferred with the tumor. A second portion was studied histologically. The third portion was transplanted to the anterior chamber of the eye of another rabbit to be sure viable cells were present and to maintain a continuous source of the same tumor. The fourth and major portion was minced and suspended in 10 ml. of sterile saline for injection into the colon.

The colon operation was performed under aseptic conditions. A 15 cm. segment of the colon just distal to the ileocecal area was isolated between two noncrushing clamps. This was milked clean and the tumor suspension was injected into the colon between the two clamps. The colon was divided and some spillage of tumor cells and content of the colon was permitted. An anastomosis with a single layer of continuous No. 4–0 silk re-established continuity of the bowel.

The animals were sacrificed from twenty-four to fifty-nine days after operation and autopsied for evidence of tumor transplantation.

The contents of the colon were subjected to aerobic and anaerobic quantitative bacteriologic analysis to determine the specific bacteriologic content of the material that might have any influence on the growth of tumor cells in each particular experiment.

METHOD

Series I. This was the control study. Tumors were found in thirty-seven of the forty-four animals. Tumor implantation at the anastomotic site, the most important location from the standpoint of this study, was present in eighteen experiments. (Fig. 1.) Growth of tumor tissue at the site of injection, where the highest concentration of tumor would be expected, was present in only two experiments.

Series II. Series II was designed to study the role of intestinal antisepsis. We were unable to

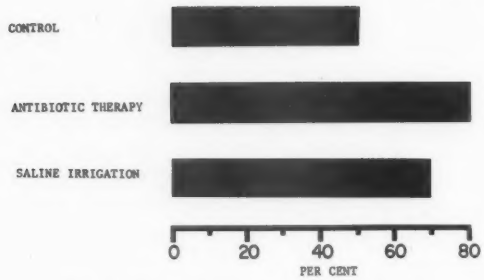

FIG. 1. Incidence of tumor at anastomosis.

control the unusual intestinal flora of the rabbit with orally administered drugs, as reported by Vink, and had to resort to a technic of intraluminal injection of antibiotics to obtain a sterile segment of colon for injection of tumor cells.

The experimental technic varied from that already described in some details. Before the tumor cells were injected, 10 ml. of sterile saline were injected between the clamps. This was milked past the distal clamp. Then a solution (10 ml.) containing 750 mg. of neomycin and 150 mg. of tetracycline was injected into the colon. This was allowed to remain in place for thirty minutes after which it was milked past the distal clamp. Then the tumor suspension was injected into the colon. The remainder of the procedure was the same as that previously described.

Tumors were found in thirty-seven of the forty experiments. Tumor implantation was found at the anastomotic site in twenty-nine experiments, and the increased incidence of tumors at this site was statistically significant when compared to the control series. (Fig. 1.) Intraluminal ulceration from tumors was found in ten of these experiments as contrasted to only one of the control series.

Series III. The third series was designed as a control on the additional operative trauma induced in Series II by the intraluminal injection of antibiotics and the repeated milking of the bowel necessitated by the injection of various substances into the colon. All procedures were identical to that in Series II, except that saline was substituted for the intraluminal instillation of antibiotics for the same time period.

Tumor tissue was found at the anastomosis in sixteen of the thirty experiments in this series. (Fig. 1.)

BACTERIOLOGY

The incidence of all organisms was reduced by saline irrigation and was further reduced by the antibiotic therapy. While this seems to indicate that control of the bacterial flora was superior in the treated series, actual counts showed relatively insignificant differences between the treated and the saline series. This unexpected finding should not be transposed to the clinical patient and mechanical milking of the bowel at the time of surgery substituted for proper cleansing of the colon. It is interpreted only to mean that under the specific conditions of this particular experiment, it was possible to significantly reduce the bacterial flora of the colon in the rabbit by the simple mechanical expedient of repeated flushing of a small segment of colon with sterile saline.

Series IV and V. The results presented have demonstrated a higher rate of tumor growth in the anastomotic line in the presence of a controlled bacterial flora. Since these experiments were not subject to all the complicating factors which might influence such a study under clinical conditions, and since these studies confirm other work of both a clinical and an experimental nature, it seems that there should no longer be any question about whether or not intestinal antisepsis may influence the rate of tumor growth at an anastomotic line in the colon. Once this is accepted, it becomes obvious that there would be advantages to any agent which could be used to combat this influence of the antibiotics without simultaneously altering the beneficial effects of antibiotics on other phases of colon surgery. One such agent now being advocated by some surgeons is Clorpactin® XCB. This portion of the study is an attempt to determine the antitumor effect of Clorpactin XCB on the specific tumor with which this study is involved.

Clorpactin XCB was used to irrigate the peritoneal cavity after the anastomosis of the colon had been completed in an attempt to wash out any tumor cells that might have been spilled and thus duplicate the conditions under which the agent has been used clinically. For the irrigation 100 ml. of a 0.5 per cent solution of Clorpactin XCB was freshly prepared for each experiment. This was allowed to remain in the peritoneal cavity for five minutes after which as much as possible was aspirated prior to closure of the abdominal cavity. A paired

animal which received identical amounts of tumor under identical conditions was subjected to peritoneal irrigation with the same amount of saline solution to duplicate the mechanical effects of such irrigation without introducing any antitumor agent. The other aspects of the experiment remained similar to that previously described except for the addition of the further controls introduced in this study in the form of paired experiments, mechanical mixing of the tumor suspension and tumor cell counting.

Of the nineteen paired experiments already completed tumors were found in ten saline controls and in sixteen animals treated with Clorpactin. (Fig. 2.) Massive tumor growth was present in five of the group treated with Clorpactin as compared to none of the control group. Thus Clorpactin was *less* effective than plain saline in the prevention of tumor implantation in the peritoneal cavity. The animals treated with Clorpactin had a higher incidence and a greater degree of tumor growth than did their control paired experiments.

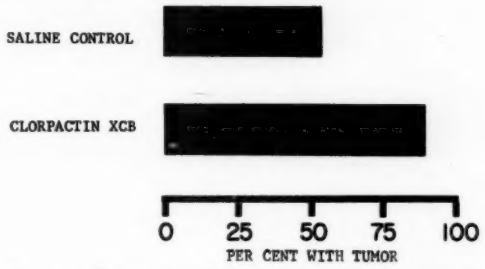

FIG. 2. Tumor implantation in nineteen paired experiments.

COMMENTS

The question of whether or not intestinal antisepsis might increase the spread of tumors of the colon has not been given the consideration it deserves in spite of the appearance of Vink's paper. Since preoperative intestinal antisepsis is almost routinely used by those interested in surgery of malignant disease of the colon, this aspect of intestinal antisepsis needs further study. This project was undertaken in an attempt to repeat and extend Vink's work to further evaluate the relationship between intestinal antisepsis and the spread of tumors.

The presence of tumor at the anastomosis in 50 per cent of *all* animals in this study and various clinical studies of the same problem amply demonstrate that tumor cells in the lumen of the bowel can be implanted in the suture line at the time of resection. The importance of tumor spillage and subsequent growth outside the lumen of the bowel is also emphasized, since over 80 per cent of all animals in the study had tumor growth in various intraperitoneal locations.

The most important question under consideration was whether control of the bacterial flora would influence the growth of tumor at the anastomosis. Under the conditions of this study this question must be answered in the affirmative, since tumors were present at the anastomosis in 78 per cent of the antibiotic experiments as compared to only 48 per cent of the control experiments and this difference is statistically significant. If one combines the antibitotic and the saline instillation series, since there was no real difference between these two with respect to the bacterial flora of the bowel, it may be said that there is a difference between the incidence of tumor takes at the anastomosis in those animals with a normal gastrointestinal flora and those animals in which this flora has been diminished by whatever means.

These studies have emphasized the desirability of finding an agent which could be used to combat the influence of intestinal antisepsis on tumor spread. Clorpactin XCB is used by some to irrigate the peritoneal cavity in the hope that this will kill any tumor cells spilled in the peritoneal cavity and thus lower the incidence of implantation metastasis following procedures for intra-abdominal malignancy. In this study Clorpactin was *not* effective in this regard and, therefore, could not be recommended. The group which received Clorpactin actually had more tumors than the group which was given saline irrigations. Obviously an agent that is no more effective than saline could not be recommended since it offers no antitumor advantages over saline, and has the disadvantage of not being as well tolerated by the tissues as is saline.

SUMMARY

The Brown-Pearce tumor in the rabbit has been used to study the fate of free tumor cells in the lumen of the colon.

Experimental studies have shown that tumor cells can be implanted during an anastomosis of the colon and subsequently produce tumor in the anastomotic line.

Tumor cells spilled during an open anastomosis of the colon will grow in the peritoneal cavity.

Control of the bacterial flora of the colon plus increased trauma to the colon will significantly increase the incidence of tumor growth in the anastomosis.

Clorpactin does not seem to be useful in the prevention of tumor spread from the gastrointestinal tract.

The importance of controlling the spill of tumor during open operations on the gastrointestinal tract is stressed.

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Cancer of the Colon and Rectum

A STUDY OF THE ROUTES OF METASTASES

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CARCINOMAS of the large bowel metastasize by four main routes; direct extension into adjacent organs, dissemination of malignant cells into the circulating blood, passage of tumor cells to the regional lymph nodes and into the lymph of the thoracic duct and thus to the systemic circulation, and exfoliation of tumor cells into the peritoneal cavity and the lumen of the bowel. The prevention and control of metastasis is the responsibility of anyone who performs surgery on the colon or rectum. Adequate excision of the tumor including the area of lymphatic spread has been recommended [1] as well as the early ligation of the regional blood vessels and the lumen of the bowel [2] to prevent dissemination by these routes. Recent technics in the use of the anticancer agents as an adjuvant to surgery hold promise in irradicating the circulating tumor cells before they form metastases [3].

We have been interested in the dissemination of tumor cells from colonic and rectal cancers by the vascular and lymphatic routes and their exfoliation into the peritoneal cavity.

METHODS

Peripheral blood samples were obtained from the antecubital vein, and regional blood samples were obtained from the veins draining the tumor area before, during and after any surgical procedures. The blood samples were studied for the presence of tumor cells utilizing the fibrinogen technic [4]. The stages of tumor involvement were recorded by our Department of Pathology. Lymph was obtained by cannulation of the left thoracic duct. An aliquot of lymph was centrifuged and the cellular sediment examined for the presence of tumor cells [5]. Peritoneal washes with physiologic saline were obtained at the onset and conclusion of each surgical procedure. The cellular sediment was examined for the presence of tumor cells [6].

RESULTS

Twenty-eight patients with carcinoma of the colon which was amenable to a "curative" type of surgical procedure have had blood and peritoneal washings examined for tumor cells. (Table 1.) Tumor cells were identified in the peripheral blood of three of twenty-four patients (12.5 per cent) and in the regional blood in eight of twenty-two patients (36 per cent). One patient had tumor cells in both peripheral and regional blood samples. Two of the three patients with tumor cells in the peripheral blood had serosal invasion by the tumor and tumor cells in the peritoneal cavity. Eight of twenty-one patients with negative peripheral blood samples had tumor cells in the peritoneal cavity, six patients had associated serosal invasion, one had invasion of adjacent tissue, and two had ascites and tumor implants. Five of the eight patients with tumor cells identified in the regional blood had tumor cells in the peritoneal cavity. Four patients had serosal invasion, and one had metastases to lymph nodes. Six of the fourteen patients with negative regional blood samples had tumor cells in the peritoneal cavity. Four had serosal invasion and one had metastases to lymph nodes. In none of the twenty-eight patients did the tumors show invasion of blood vessels.

Sixty-five patients with carcinoma of the rectum amenable to a "curative" surgical procedure have had blood and peritoneal

TABLE I

CANCER DISSEMINATION IN CARCINOMA OF THE COLON AMONG TWENTY-EIGHT PATIENTS WITH SURGICALLY "CURABLE" LESIONS

Tumor Cells in Blood	No. of Patients	Other Blood	Peritoneal Washing (positive)	Metastasis				
				Serosal	Vessel	Tissue	Lymph Node	Ascites Implants
Peripheral								
Positive	3	1*, 1†	2	2	0	0	0	0
Negative	21		8	6	0	1	2	2
Regional								
Positive	8	1‡, 5§	5	4	0	1	2	0
Negative	14		6	4	0	0	1	0
Total Positives	11		7	6	0	1	2	0

* Regional blood positive.
† Regional blood negative.
‡ Peripheral blood positive.
§ Peripheral blood negative.

washings examined for the presence of tumor cells. The findings are given in Table II. Four of sixty patients (6.6 per cent) had tumor cells identified in the peripheral blood and seven of fifty patients (14 per cent) had tumor cells identified in the regional blood. None of the patients had tumor cells identified in both the regional and peripheral blood. One of the four patients with tumor cells in the peripheral blood had tumor cells in the peritoneal cavity, one had invasion of adjacent tissues by tumor, three had metastases to lymph nodes, and one had ascites. Seven of the fifty-six patients with negative peripheral blood samples had tumor cells in the peritoneal cavity. Seventeen of these had serosal invasion, two had invasion of blood vessels, seven had invasion of adjacent tissues by tumor, fifteen had metastases to lymph nodes, and one had peritoneal implants. One of the seven patients with tumor cells in the regional blood had tumor cells in the peritoneal cavity, three showed serosal invasion, one had

TABLE II

CANCER DISSEMINATION IN RECTAL CARCINOMA AMONG SIXTY-FIVE PATIENTS WITH SURGICALLY "CURABLE" LESIONS

Tumor Cells in Blood	No. of Patients	Other Blood	Peritoneal Washing (positive)	Metastasis				
				Serosal	Vessel	Tissue	Lymph Node	Ascites Implants
Peripheral								
Positive	4	2*	1	0	0	1	3	1
Negative	56		7	17	2	7	15	1
Regional								
Positive	7	5†	1	3	0	1	3	0
Negative	43		8	10	2	8	13	2
Total Positives	11		2	3	0	2	6	1

* Regional blood negative.
† Peripheral blood negative.

TABLE III

LYMPH AND BLOOD DISSEMINATION IN COLON AND RECTAL CARCINOMA AMONG TWELVE PATIENTS WITH ADVANCED DISEASE

Site	No. of Patients	Thoracic Duct Lymph		Peripheral Blood		Pulmonary Metastases	
		Positive	Negative	Positive	Negative	Positive	Negative
Colon	3	0	3	0	3	1	2
Rectum	9	0	9	1	5	4	5

invasion of adjacent tissues and three had metastases to lymph nodes. Eight of the forty-three patients with negative regional blood samples had tumor cells in the peritoneal cavity, ten had serosal invasion, tumor invasion of blood vessels was noted in two, eight had invasion of adjacent tissues, thirteen had metastases to lymph nodes, and two had ascites or tumor implants.

Table III gives the results of the examination of lymph from the thoracic duct and peripheral blood for tumor cells in twelve patients with advanced carcinoma of the colon and rectum. In three patients with disseminated carcinoma of the colon no tumor cells were identified in the lymph or blood, and one of these patients had pulmonary metastases. In nine patients with advanced carcinoma of the rectum no tumor cells were found in the lymph; however, one of six patients examined had tumor cells in the peripheral blood and four of the nine patients had pulmonary metastasis.

COMMENTS

Tumor cells were found more frequently in the regional blood of patients with early carcinomas of the colon and rectum. The identification of tumor cells in the regional or peripheral blood of 36 per cent of patients with cancer of the colon, and 17 per cent of patients with rectal cancer emphasizes the importance of this route of spread. The exfoliation of tumor cells into the peritoneal cavity was associated with serosal invasion by the tumor. In patients with carcinoma of the colon there was an association between tumor cells in the blood and in the peritoneal cavity. There was no relationship between tumor cells in the blood and tumor cells in the peritoneal cavity in patients with carcinoma of the rectum. Blood vessel invasion was not seen in any of the surgical specimens of the twenty-eight patients with carcinoma of the colon; however, an examination of this type must be limited to the small tissue sections being examined. Four of the patients with cancer of the rectum had invasion of blood vessels by tumor, but in none of these were we able to identify tumor cells in the blood. The sampling error in examining the circulating blood for the presence of tumor cells is large. Therefore, a negative examination has less significance, even if several samples are obtained. There appears to be no relationship between the occurrence of tumor cells in the blood or peritoneal cavity and the finding of tissue invasion, or metastases to lymph nodes. Abdominal carcinomatosis with ascites and tumor implants is associated with the presence of malignant cells in the ascitic fluid. However, ascites in this series of patients was either very minimal or the implants were limited to a local area so that washings of the general peritoneal cavity could avoid contact with the tumor area.

It is of interest that none of the patients with advanced carcinoma of the colon and rectum had tumor cells in the lymph from the thoracic duct. Lymph node metastases are common in these tumors; perhaps these lymph nodes act as filters to prevent the malignant cells from passing freely up the thoracic duct. Pulmonary metastases were present in five of the patients, and tumor cells were identified in the peripheral blood of one of the patients. This may indicate that the vascular route is more important than the lymphatic route in the production of pulmonary metastasis by colorectal carcinoma.

SUMMARY

In twenty-eight patients with surgically "curable" carcinomas of the colon, tumor cells

were identified in the peripheral blood in 12.5 per cent of the patients and in the regional blood of 36 per cent of the patients. There may be a slight increase in the occurrence of tumor cells in the peritoneal cavity and serosal invasion by the tumor in the patients with tumor cells in the blood. No relationship was apparent to blood vessel invasion, invasion of adjacent tissues, metastases to lymph nodes or ascites and tumor implants. Tumor cells were identified in the peripheral blood of 6.6 per cent of sixty-five patients with surgically "curable" rectal cancer, and in the regional blood of 14 per cent of these patients. The finding of tumor cells in the peritoneal cavity was associated with serosal invasion by the tumor, but no relationship was apparent between the occurrence of tumor cells in the blood and the finding of tumor cells in the peritoneal cavity, serosal invasion, blood vessel invasion, invasion of adjacent tissues, lymph node metastases or the presence of ascites or tumor implants. The lymph from the thoracic duct does not appear to be an important route for the spread of tumor cells from colon or rectal cancer, and the occurrence of pulmonary metastasis may indicate vascular rather than lymphatic spread. It appears that each route of dissemination of cancer cells in patients with colon or rectal carcinoma is relatively independent of other factors, and must be considered separately in any surgical efforts to control the disease.

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Tissue Culture of Cells Recovered from the Blood of Patients with Colonic and Rectal Cancer

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THE recovery of cancer cells from the regional venous blood of patients with colonic and rectal cancer has been reported by investigators in our laboratory as well as by others [1–5]. Many of these cells appear to be viable when stained specimens are examined, but their definite biologic viability has not been established. It is possible that many of these cells have been exfoliated by the parent tumor and no longer are viable and capable of sustained growth in distant areas. However, clinical evidence suggests that many of these cancer-cell emboli are potential sources of new tumor foci unless destroyed by mechanisms of basic host resistance, immunity, or systemic chemotherapy.

The purpose of this investigation was to determine the viability of cancer cells recovered from the blood of patients with cancer of the colon and rectum. Tissue culture growth of the cancer cells was used as evidence of their potential ability to produce tumor growth. Blood specimens were obtained from the inferior mesenteric or superior hemorrhoidal veins as well as the peripheral veins (antecubital) in fourteen patients with cancer of the colon and six patients with cancer of the rectum. The specimens of blood were passed through the recovery process and the recovered cells were cultured. Cells identified as malignant grew in the cultures of specimens recovered from the regional venous blood of two patients. Cells which were atypical grew from the culture of a specimen of systemic venous blood from one of these patients but these cells could not be classified as malignant. Systemic venous blood specimens from twenty normal patients without malignancy were cultured. The only cells growing in these cultures were easily identified histiocytes.

METHOD

Blood specimens (10 ml.) were obtained from the inferior mesenteric veins or from one of the hemorrhoidal veins of twenty patients who were operated on for cancer of the colon and rectum. These specimens were obtained prior to any operative manipulation or dissection beyond that required to obtain the blood sample. At the same time a specimen of peripheral blood (10 ml.) was obtained from a systemic vein, in most instances from one of the antecubital veins. The specimens were collected in sterile culture tubes to which 100 units (0.1 ml.) of heparin sodium had been added to prevent coagulation. Initially, cancer cells were recovered from the blood specimens according to the isolation procedure described by Roberts et al. [5], utilizing bovine fibrinogen to rapidly sediment the erythrocytes and layering the supernatant plasma over bovine albumin. However, only the initial step of sedimenting the erythrocytes with fibrinogen was used in the latter half of the investigation for fear that some of the cells were being lost during the second step. This was the method used by Sandberg and Moore [6] for the concentration of tumor cells in blood. The fibrinogen solution which was used was obtained commercially* and had been rendered isotonic and adjusted to a pH of 7.4 as suggested by Roberts et al. Sufficient fibrinogen solution was added to each specimen so that the final concentration of fibrinogen in the specimen would be

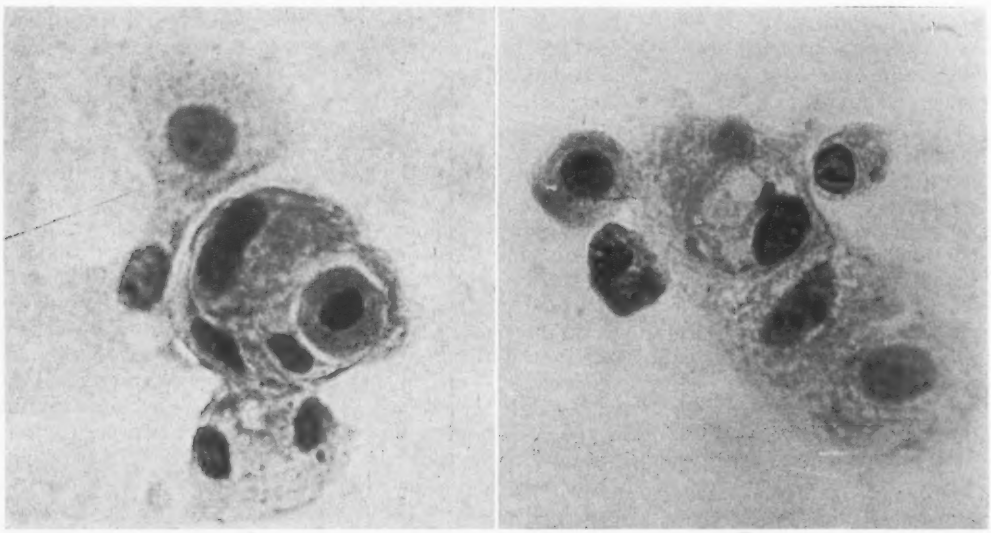
* Pentex, Inc., Kankakee, Illinois.

TABLE 1
MALIGNANT CELLS IN CULTURES OF BLOOD SPECIMENS FROM TWENTY PATIENTS WITH CANCER

Site of Cancer	No. of Patients	Positive Cultures		
		Number	Source	Status of Patient
Colon	14	1	Inferior mesenteric vein	Potentially curable, regional metastases
Rectum	6	1	Inferior mesenteric vein	Incurable, palliative resection
Total	20	2		

6.7 mg./ml. at a hematocrit of 27 per cent, utilizing the formula of Buckley et al. [7]. The supernatant material then was decanted and centrifuged at 1,000 r.p.m. for ten minutes. After two washings in balanced salt solution (Hanks [8]) the resulting sediment was cultured in Beckman beakers in which No. 0 round coverslips had been placed. These completely covered the bottom of each flask and provided a growing surface for the cells which could be removed, fixed, and stained for microscopic examination. Two milliliters of culture medium were added to each flask followed by 0.1 ml. of the sediment to be cultured. The flasks were stoppered with No. 4 styrene stoppers and maintained in an incubator at a constant temperature of 37°C. for twenty-one days. The coverslips were removed and fixed in formalin-acetic acid-alcohol and stained with hematoxylin and eosin. A few were fixed in ether-alcohol and stained by the Papanicolaou technic [9].

Sterile portions of the primary tumor or lymph nodes involved in tumor growth were obtained as soon as the surgical specimen was removed. A direct smear of the tumor was made and stained by the Papanicolaou technic. Comparison of the cells in the tumor smear with cells growing in the cultures aided in the identification of malignant cells in the cultures. A suspension of tumor cells was prepared by mincing the tumor with eye scissors and adding 3 to 4 ml. of balanced salt solution (Hanks). The suspension of tumor cells was cultured in the same manner as was the sediment obtained from the blood specimens, adding 0.1 ml. aliquots of the suspension to 2 ml. of medium in each of several flasks. These were incubated at 37°C. for twenty-one days, after which the coverslips were removed for fixing, staining and mounting on slides for microscopic examination. The culture medium was Eagle basal medium [10] with 20 to 40 per cent autologous serum



A B

FIG. 1. A, cells growing in culture of regional blood specimen obtained from a patient with a potentially curable carcinoma of the colon. B, cells growing in culture of primary tumors (from involved lymph node) from the same patient. Magnification × 1,000.

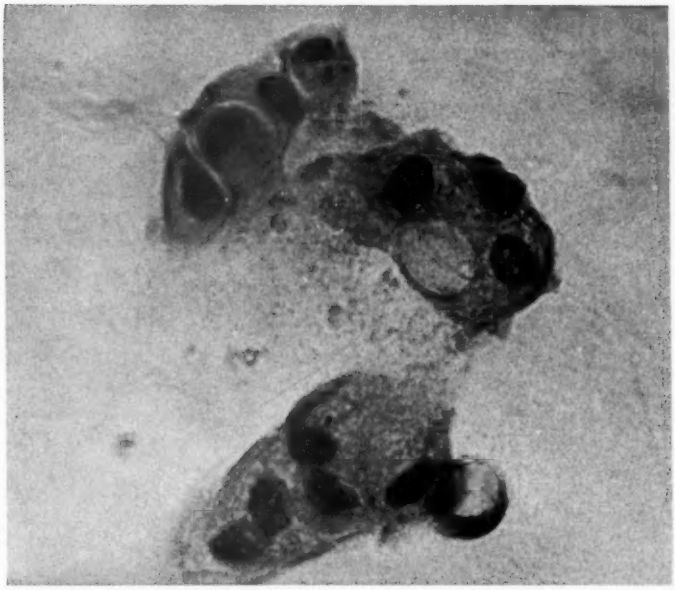


FIG. 2. Cells growing in culture of regional blood specimen obtained from patients with rectosigmoid cancer which was resectable but had metastasized to the liver. Magnification × 1,000.

added. If sufficient autologous serum was not available, homologous serum was used.

RESULTS

Cells which could be identified as malignant grew in the cultures of specimens obtained from two of the twenty patients with cancer of the colon and rectum. Both specimens were obtained from the inferior mesenteric veins of the patients. One patient had a carcinoma of the sigmoid colon which extended through the bowel wall to involve the serosa and the regional lymph nodes. However, no lymph nodes proximal to the point of resection were involved with tumor and the patient was classified as having potentially curable disease (Table 1). Cells which grew from the cultures of the regional blood specimen obtained from this patient tended to cluster in rosettes as if they were trying to form glandular structures. (Fig. 1A.) In this photomicrograph there are numerous intercellular spaces, but no large areas of mucus are seen. However, other cells not shown in this photomicrograph showed definite production of mucus. The nuclei of the cells are irregular in shape and size, and the nuclear membranes are thick and densely staining. The more centrally located nuclei contain a large amount of densely staining chromation, though the nucleoli are not large. A group of cells which grew from the culture of the primary tumor are shown in Figure 1B. In each instance the primary tumor was cultured so that cells growing in the cultures of the primary tumor could be compared with those growing in the cultures of the blood specimen as an aid in identifying malignant cells. The cells in Figure 1B are quite similar to those in Figure 1A. Cells in both cultures show some attempt at alveolar formation and the nuclei are quite similar in shape and size.

The second patient had a carcinoma of the rectosigmoid with extensive local invasion at the peritoneal reflection. There was extensive tumor involvement of the regional lymph nodes and two metastatic tumor nodules were observed in the left lobe of the liver. This patient was classified as inoperable and a palliative resection was performed. Cells which grew from the cultures of a specimen of blood withdrawn from the inferior mesenteric vein of this patient prior to tumor resection are shown in Figure 2. For comparison cells growing from the cultures

FIG. 3. Cells growing in culture of primary tumor obtained from node involved in tumor growth in patients with rectosigmoid carcinoma. Magnification × 1,000.

of the primary tumor are shown in Figure 3. The cells in both cultures are similar with similar sized nuclei which are irregular and have heavy nuclear membranes. Both groups of cells have produced mucus. Large nucleoli and densely staining chromation appear within the nuclei of cells from both cultures. A large fibroblast is seen in the lower left corner of Figure 3, a photomicrograph of the culture of the primary tumor. The cytoplasm of the fibroblast is barely visible and the ovoid nucleus is quite large, containing only a small amount of chromation.

COMMENTS

The identification of individual cells or groups of cells as malignant is difficult. This is especially true if the cells have been grown in tissue culture preparations. In this investigation we attempted to obviate this difficulty by comparing the cells which grew from blood specimens of patients with cancer with cells which grew from the primary tumors of these same patients. In both cases the cells which grew in culture produced mucus as did the cells growing in the cultures of both primary tumors. This alone strongly suggests malignancy as none of the elements normally found in the blood could be expected to produce mucus. In addition comparisons of the morphology of the cells cultured from the blood specimen with those from the primary tumor in each case showed close similarity.

The only other valid method of demonstrating viability of cancer cells recovered from the blood is the reinoculation of the cells back into the host (patient). As previously reported we have reinoculated the sediment recovered from the blood of eighteen patients with various types of malignancy. However, we were able to obtain growth in only one patient [*11*]. This patient had a rapidly growing malignant melanoma involving the left axilla. A blood specimen was obtained from the right antecubital vein and passed through the isolation process. The sediment was divided into two portions and injected suprafascially at measured distances from the umbilicus. A third area was injected with physiologic saline as a control. Four and a half months elapsed before tumor nodules were palpable at the site of injection of the recovered cells. The nodules were excised and tumor confirmed by microscopic examination. The interesting phenomenon was the

relatively long period necessary for the inoculated tumor to achieve palpable size. This period was four and a half months with a very rapidly growing tumor. The failure to obtain growth in the other cases could be due to this lag between inoculation and time of rapid proliferation. The primary tumors in the other seventeen patients who were reinoculated were more slowly growing tumors of the gastrointestinal tract (stomach, colon, and rectum). As the patients chosen for reinoculation were suffering from advanced malignancy, none of them lived longer than five months following inoculation and most of them lived for only two to three months. If they had lived longer, it is conceivable that tumor nodules would have developed at the sites of injection in at least some of the patients.

One of the positive blood cultures in this study was obtained from a patient with potentially curable cancer of the colon. This finding demonstrates that vascular embolization occurs at a relatively early period in the life cycle of such tumors. The patient may be able to kill or otherwise render ineffective many of these cancer cell emboli. However, there is real danger that large numbers of cells may be dislodged into the blood stream during surgical manipulation and overwhelm the defensive mechanisms of the patient. For this reason the surgeon should design his procedure so that, whenever possible, all vascular and lymphatic pathways from the tumor can be divided before any surgical resection or tumor manipulation is attempted.

SUMMARY

Blood specimens were obtained from the inferior mesenteric veins of twenty patients with colonic and rectal cancer prior to surgical resection. After passage through the recovery procedure, the sediment was cultured, using standard tissue culture technics.

Cells identified as malignant grew from the cultures of blood specimens from the inferior mesenteric veins of two of these patients, one with curable cancer of the colon and the other with an incurable but resectable rectal cancer. The identification of malignant cells in tissue cultures is difficult but was aided by comparison with cells growing in cultures of the primary tumors. The demonstration of viable cancer cells in the mesenteric venous blood of a patient with curable cancer of the colon indicates the need for early ligation of vascular and lymphatic pathways before surgical resection or manipulation of the tumor is performed.

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Prevention of Implantation of Cancer Cells in the Wound by Irrigation with Anticancer Agents

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For decades the medical profession, particularly surgeons, has been aware of the implantation of cancer cells into the wound during operation for malignant disease with the development of local recurrences. However, insufficient attention has been given to this danger throughout the years. Perhaps the first one to call attention to this possibility was Gerster [1] in 1885. He reported an extremely rapid dissemination of a melanoma in a patient following local excision and later amputation. A few years later, Lack [2] emphasized the danger of dissemination by direct implantation of cells, and warned that recurrence might be produced by contamination of instruments, sponges, and surgeon's hands with cancer cells and the ultimate transfer of these cells into the wound. He reported several cases illustrating this mechanism of recurrence. A more detailed report with more examples was made by Ryall [3] in 1906 in which he discussed twenty-five patients who developed recurrence in the wound or in the needle track made during the operation. Sixteen of these recurrences were in the scar of the operative wound; two followed operation for cancer of the breast, five developed after celiotomy, five followed for excision of cancer of the neck, and two developed in the perineal wound following operation for cancer of the rectum. He reports the development of cancer in five patients in the track made by the needle used to close the wound. One recurrence was encountered at the drainage site after operation for cancer of the breast. Saphir [4] has identified tumor cells on the scalpel used by the surgeon during a biopsy or excision of the cancer. Ackerman and Wheat [5] recently made a study of implantation of cancer cells and reported several cases in which this complication had occurred. In one of the patients recurrence occurred in the skin graft following a radical excision of the breast. In another patient it developed in the donor site following a skin graft of the chest wall. Three different groups [6–8] have emphasized the possibility of implantation of cancer cells into the cut edge of the bowel during an end to end anastomosis following resection of the colon.

The reports listed above represent only a few examples of reports warning against the danger of implantation of cells as a cause of local recurrences. It is our opinion that more effort should be made to prevent the dislodgment of cancer cells and their implantation into the wound.

Haverback and Smith [9] have recently published experimental data indicating that sutures might be contaminated with cancer cells and be the indirect cause of local recurrences. They passed a suture through a solid tumor (mast cell tumor and 591 melanoma in DBA/P mice) and then passed the suture through the leg of normal mice. This procedure resulted in the development of a tumor at the point where the contaminated suture passed through the leg in 49 per cent of the mice. When the suture was dipped in a suspension of malignant cells and then passed through the leg of mice, the "takes" were nearly 100 per cent; however, when the suture was dipped in 7.3 per cent picric acid solution for 20 seconds, "takes" were prevented in practically all of the animals. Similar results were obtained with other anticancer agents.

Opinions differ as to the percentage of patients having local recurrence due to implantation of cancer cells. The highest percentage of recurrences reported occur in the neck. There is an obvious reason for a high recurrence rate in that area. Many of the primary tumors (in the mouth) are ulcerated, and there is never a wide margin between the edge of the tumor and the edge of the mass resected. In many patients it is difficult to determine whether the recurrence is due to an implantation or due to failure to remove all of the tumor. In general, it might be assumed that if the recurrence arose deeply and was attached to deep structures, the cause might be failure to remove all of the tumor. On the contrary, if the nodule is mobile and superficial, the recurrence was probably due to implantation of cells during the operation. The recurrence rate reported following radical resection for tumors of the neck varies between 20 and 40 per cent. For example, Wilkins [*10*] reported recurrence in 23.9 per cent of patients whereas Harrold [*11*] reports a recurrence rate of 43.6 per cent. The recurrence rate in patients who have had a radical mastectomy varies from 10 to 15 per cent. Robnett and his associates [*12*] report an incidence of 14.2 per cent, while Taylor and Wallace [*13*] report an incidence of 15 per cent in patients having a biopsy just preceding radical mastectomy, contrasted to 7.5 per cent in patients not having a biopsy before radical mastectomy. Haagensen [*14*] reports an incidence of 10.5 per cent. White [*15*] reports recurrences in 10.8 per cent of the patients when the axillary nodes were negative and 31.5 per cent in patients who had positive axillary nodes.

TABLE 1

EXPERIMENTAL IRRIGATION OF WOUNDS INOCULATED WITH CANCER CELLS (WALKER 256) ONE HOUR PREVIOUSLY*

Type of Solution	No. of Rats	Tumor Growth (%)
Control (no irrigation)	281	95
Isotonic saline	32	100
Oxytetracycline	30	100
Distilled water	10	100
Heparin, 10 mg. %	10	100
Saline, 3 %	31	90
Monoxychlorosene (Clorpactin), 0.5%	30	86
Phenol, 0.1%	36	86
Sodium sulfadiazine, 1 gm.%	30	83
Chloroazodin (Azochloramide) 0.05 mg.%†	25	80
Benzalkonium chloride (Zephiran®), 1:1,000	35	71
Mercury bichloride, 1:1,000	30	66
Ethyl alcohol, 95%	7	57
Monoxychlorosene 1%	30	46
Monoxychlorosene 1.5%‡	30	36
Strong iodine solution (U.S.P. Lugol's solution), ½ strength	30	23
Unbuffered sodium hypochlorite, 0.5%	112	13
Formaldehyde, 0.3%	50	12
Formaldehyde, 0.4%‡	50	10
Styrlquinoline, 10 mg. %	52	10
Styrlquinoline, 15 mg. %	44	9
Formaldehyde, 0.5%‡	39	8
Sodium hypochlorite, 0.5%§	56	8
Monoxychlorosene, 2%‡	107	6
Mechlorethamine (nitrogen mustard), 2 mg. %	84	4
Mechlorethamine, 1 mg.%	54	4

* Modified from McDonald, Gines and Cole, *Arch. Surg.*, 80: 920, 1960.

† Wound slough if higher concentration.

‡ Too toxic for clinical use.

§ Buffered to pH 9.0.

METHOD

In our experiments we used the Walker 256 carcinosarcoma in female albino rats. The tumor was removed under aseptic conditions, minced with fine scissors and mixed with physiologic saline solution; this mixture was then filtered through a wire mesh filter containing 80 perforations per inch. The cell suspension was made with a concentration of 20,000 unstained cells per cc. We added 1:1000 eosin solution to the suspension and considered cells which were stained to have inadequate viability.

A subcutaneous pouch was made on the ventral surface of the animal after anesthesia with intraperitoneal injections of pentobarbital. One-half cc. of the tumor cell suspension containing 10,000 unstained cells was placed in the pouch. The flap was allowed to drop back into place and we allowed an incubation period of one hour. At the end of this time, the pouch was opened with a vertical incision and irrigated with 100 cc. of the various chemicals being investigated as shown in Table 1. The time required for the irrigation was 35 seconds with the flask suspended 30 inches above the animal. The wound was then closed with fine cotton.

COMMENTS

We used about twenty-five chemicals or solutions in this study. Some of the chemicals

were used in different concentrations because it was not certain just what concentration of the solution would be tolerated by the tissues. We utilized lack of healing and appearance of the wound as an indication that the concentration was too high to be utilized clinically. Table 1 illustrates that the most effective agents were nitrogen mustard in a concentration of 1 or 2 mg. per cent, and sodium hypochlorite 0.5 per cent buffered to pH 9.0. Clorpactin is effective when used in 2 per cent solution, but this concentration is too strong for wound healing. In our experiments the effect was too meager to be considered utilizable clinically when we lowered the concentration to a level commensurate with wound healing.

Results were determined by observing the rats for development of tumors at the site of the pouch and irrigation of the wound, which had been contaminated with cancer cells.

Nitrogen mustard obviously cannot be used in the wound if this agent is being used in systemic treatment. Since sodium hypochlorite is just about as effective as nitrogen mustard we have adopted its use in our patients utilizing a 0.5 per cent buffered solution. However, sodium hypochlorite (originally called Dakin's solution) must be made immediately before use. Otherwise, the material deteriorates and produces toxic reactions.

Preparation of Sodium Hypochlorite Solution for Clinical Use. Because of the rapid deterioration of the solution of this compound, it should be prepared no longer than fifteen to twenty minutes before use. We use a stock solution of 5.25 per cent dispensed in tightly stoppered dark glass bottles. Powdered sodium bicarbonate (10.7 gm.) is stored in the refrigerator in other tightly stoppered bottles. In preparing the solution for irrigation one bottle containing 106.6 ml. of 5.25 per cent sodium hypochlorite is added to a bottle of 10.7 gm. of sodium bicarbonate. This solution is made up to 1,000 cc. with distilled water. The temperature of the water should not exceed 70°F. The addition of the 10.7 gm. of sodium bicarbonate will lower the pH to about 9.0. However the pH should be determined to be sure that there is not a marked deviation of this optimum figure. If the pH falls below 8.89 the solution becomes toxic.

Technic of Wound Irrigation in Human Patients. Although it might be desirable to irrigate the wound frequently with anticancer solutions during long operations we believe that irrigation at the end of the operation is probably sufficient. The wound is flooded with the solution which is administered with a large bulb syringe and the tissues are agitated gently to obtain better contact with the solution. We are convinced that the irrigation must proceed for a minimum of four minutes if optimum effect is to be obtained. At this point the drapes should be changed and the surgeon and his assistant should change gowns and gloves. A different set of instruments should be used for closure of the wound. If the pleural or peritoneal cavity has been entered during the operative procedure for eradication of the cancer, either cavity may be irrigated with the solution. At the end of the four-minute period of irrigation, we advise removal of the solution, although we have no evidence that a few hundred cubic centimeters would be toxic.

SUMMARY

Numerous workers during the past several decades have emphasized the danger of implantation of cancer cells at the time of operation with formation of recurrences. Unfortunately, the medical profession as a whole has not given proper attention to this danger. A survey of the literature reveals a recurrence in the wound of about 10 per cent following radical mastectomy and about 30 per cent following radical neck dissections. In a study in which we tested the efficacy of approximately twenty-five solutions in destroying implanted cancer cells in the wounds of rats, we found that nitrogen mustard 1 to 2 mg. per cent and sodium hypochlorite 0.5 per cent buffered to pH 9.0 were about equal in efficiency. We have adopted the use of 0.5 per cent sodium hypochlorite as an irrigant at the end of operations for cancer. We believe the irrigation should extend over a period of about four minutes.

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Millipore Filtration of Colonic Washings in Malignant Lesions of the Large Bowel

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THE need for earlier diagnosis of cancer of the colon is apparent since 30 per cent [1] of these patients have incurable disease when the diagnosis is made. This, coupled with the fact that cancer of the large bowel is the most common malignancy [2], has prompted our use of a Millipore filtration cytologic technic for investigating lesions in this area. The method has two advantages over others in that nonprofessional personnel are used for obtaining the cytologic specimen and Millipore filtration is used for cellular recovery. The clinical uses and the results obtained in seventy cases of colonic cancer are presented herein.

In 1949 Wisseman and his associates [3] described a cytologic technic for investigating malignant lesions of the large bowel. This has been followed by reports from other investigators [4–8]. Cytologic study of the colon has lagged due to the difficulty in cleansing this organ. Previous colonic cytologic methods have used sigmoidoscopes and/or long rectal tubes to obtain the specimen. Because of this, constant professional supervision has been necessary. In addition, in each of these former reports, recovery of cells from the specimen has been accomplished by centrifugation.

MATERIAL AND METHODS

Patients admitted to the hospital with significant bowel symptoms were selected for this study. Each had been scheduled for barium enema so that preparation for the cytologic study coincided with preparation for the barium enema.

Five hours after receiving 2 ounces of castor oil, each patient was given two or three saline enemas. The returns from the last enema were placed in an alcohol fixative and stored in a refrigerator. An aliquot of this specimen was then passed through a series of fine wire mesh sieves to remove any debris or mucus. Cells were recovered by passing the filtrate through a Millipore filter with a 5 micra pore diameter. The filter was stained according to a modified Papanicolaou method and mounted. The slides were screened for quality by a cytologist and read by two pathologists. To promote evacuation, 10 mg. of bisacodyl powder was dissolved in each liter of fluid.

RESULTS

From November 1958 to April 1960, 700 patients were studied by this method. The results obtained in sixty-six cases of primary and four cases of secondary carcinoma of the colon and rectum are presented in Table 1. Malignant cells were observed in sixty-four of the seventy

TABLE 1
MILLIPORE FILTER CYTOLOGY RESULTS IN MALIGNANT LESIONS OF THE LARGE BOWEL

Site of Lesion	No. of Patients	Cytologic Class*				Accuracy (Per cent)
		I	II	III	IV	
Cecum	7	1	0	3	3	85.5
Ascending colon	4	1	1	0	2	50.0
Transverse colon	8	0	0	1	7	100.0
Descending colon	7	0	1	1	5	85.5
Sigmoid	24	0	0	3	21	100.0
Rectum	20	1	1	5	13	90.0
Totals	70	3	3	13	51	91.5

* I = normal; II = atypical; III = suspicious of malignancy; IV = malignant cells.

cases for a 91.5 per cent accuracy. There have been three false positives (0.4 per cent).

COMMENTS

A cytologic method for investigating lesions of the large bowel would aid in differentiating benign or inflammatory processes from malignant disease. Such a technic must be accurate and reliable, safe and economical for the patient, and simple to perform.

A minimal but definite risk of perforation of the colon is associated with the use of sigmoidoscopes and long rectal tubes for obtaining a cytologic specimen. Previous technics require the physician to pass the sigmoidoscope, thus increasing the professional time spent for each study.

The Millipore filtration method, as described above, virtually eliminates the disadvantages of cytologic study of the colon. Returns from the cleansing enemas given before the barium study are utilized as the cytologic specimen. Thorough cleansing of the bowel prior to obtaining this specimen is of greatest importance. Between 750 to 1,000 cc. of the enema fluid is slowly administered while the nurses' aid massages the patient's abdomen. Usually two or three of these enemas have been sufficient both for cleansing the colon and for the cytologic specimen. Abdominal cramps, which bother some patients, have been controlled by temporarily stopping the inflow of enema fluid and massaging the abdomen. In over 700 studies the patients have had no allergic reactions or other complications.

The accuracy of Millipore filter cytology method has been reported as 91.5 per cent in this series of seventy cases of carcinoma of the bowel. These results compare favorably with those obtained by Bader and Raskin using more complicated technics. False positives have occurred in only three cases (0.4 per cent). Follow-up studies are being used to determine whether or not any of these patients may be harboring a very early carcinoma.

Since cytologic study of the colon can differentiate between a benign and malignant process, it has an advantage over the barium enema. Inflammatory lesions of the bowel, such as diverticulitis, which may be confusing by radiographic studies, will show a benign cytology. An early carcinoma developing in a case of chronic ulcerative colitis has been demonstrated by this cytologic technic. A barium enema, of course, will localize a lesion. This is not possible yet with a cytologic study. It is not proposed, however, that this type of study should replace any existing diagnostic procedures, but that it become a routine supplemental examination.

The indications for cytologic studies of the colon include: (a) diverticulitis in which radiographic studies cannot exclude the presence of a malignant lesion, (b) chronic ulcerative colitis with formation of pseudopolyps to detect early malignant changes, (c) follow-up studies after colon resection to detect recurrence of cancer, (d) symptoms of carcinoma of the colon, but negative barium enema, (e) a history of rectal bleeding, and (f) any suspicious lesion seen on barium enema.

SUMMARY

1. The results of Millipore filtration of colon washings in seventy cases of primary and secondary carcinoma of the large bowel are presented. In sixty-four cases (91.5 per cent) a malignant cytologic report was obtained.

2. In cases in which other diagnostic studies are inconclusive, a positive cytologic examination may prove the presence of a malignant lesion.

3. The Millipore filter cytology technic is recommended for investigating all lesions of the large bowel, particularly in: (a) diverticulitis with formation of stricture, (b) chronic ulcerative colitis with formation of pseudopolyps, (c) follow-up studies after colon resection for carcinoma, (d) colonic symptoms but negative roentgenographic examination, (e) rectal bleeding, and (f) any suspicious lesion seen on barium enema.

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Detection of Cancer and Adenomas of the Colon

THE DIAGNOSTIC VALUE OF FECAL BLOOD TESTS

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TESTS for blood in the stool have long been used to aid in the early detection of cancer of the colon. Such tests are generally used to screen patients in order to eliminate those without tumors of the colon from further study [*1–8*]. However, many studies have shown that fecal blood tests may be negative in a significant number of patients with cancer of the colon [*9–11*]. Has too much confidence been placed in these tests? Are we justified in expending valuable laboratory time in routinely performing large numbers of such tests? To help answer these questions, we evaluated two commonly used fecal blood testing reagents, benzidine hydrochloride and gum guaiac. By using the same laboratory method with each reagent, we determined the accuracy of each in predicting the presence of cancer of the colon or adenomatous polyps.

METHOD

Cases in this study were taken from a series of 10,068 consecutive patients who underwent proctosigmoidoscopy. Both inpatients and outpatients were included. Most sigmoidoscopies were routinely performed as part of the initial physical examination of the patient.

Prior to digital rectal examination or proctosigmoidoscopy, naturally evacuated stools were collected for blood tests. In addition to this sample, and occasionally in place of it, gross fecal material recovered in the presigmoidoscopic enema return was also tested for blood. After discharge or completion of diagnostic studies, each patient's medical record was reviewed and data for this study compiled.

Most tests for fecal blood are based on the ability of hemoglobin to catalyze the oxidation of a colorless reagent to a colored product. Our fecal blood testing method was simple and inexpensive. It differed from the usual guaiac procedure performed in the office in this way. Certain steps were included to elminate common sources of false positive reactions [*12–19*]. Quantitative technic was used to insure reproducible results. Centrifugation was used primarily to eliminate meat fibers. The specimen was then boiled to destroy any vegetable peroxidases present. Color controls were run with each test for comparison with the specimen reaction. Any color change developing within one minute after the addition of hydrogen peroxide was considered positive.

I. Preliminary procedure

- A. Measure accurately 5 gm. (or 5 ml.) of the stool specimen
- B. Add approximately 20 cc. H_2O and mix
- C. Bring to mark at 40 ml. with H_2O
- D. Centrifuge for 20 minutes at 2,000 rpm
- E. Pour off approximately 10 cc. supernatant
- F. Boil supernatant fluid for exactly 2 minutes
- G. Cool to room temperature

II. Procedure with benzidine hydrochloride reagent

- A. To duplicate tubes (A and B) add 1.5 ml. benzidine hydrochloride
- B. To both A and B add 1.0 ml. supernatant specimen

TABLE I
CONTROL GROUP

Test	No Tumor (%)	Hemorrhoids (%)
Positive benzidine.....	12	13
Positive gum guaiac.....	19	17
With symptoms.....	25	33
Total*.....	2,432	553

* Number of patients.

C. To tube B add 0.5 ml. H_2O
D. To tube A add 0.5 ml. (0.6 per cent) H_2O_2
E. Take readings at exactly 1 minute

III. Procedure with gum guaiac reagent
A. To duplicate tubes (A and B) add 1.5 ml. supernatant specimen
B. To both A and B add 1.0 ml. gum guaiac
C. To tube B add 0.5 ml. H_2O
D. To A add 0.5 ml. (0.6 per cent) H_2O_2
E. Take readings at exactly 1 minute

The benzidine hydrochloride solution is made as follows: 10 gm. of benzidine hydrochloride are dissolved in 200 cc. of glacial acetic acid, 300 cc. of distilled H_2O are added, then a sufficient quantity of 95 per cent alcohol to make 1,000 cc. of solution is added. Gum guaiac solution is made by dissolving 8 gm. of gum guaiac in 500 cc. of 95 per cent alcohol.

In vitro studies showed that the benzidine hydrochloride test was sensitive to 10 mg. per cent hemoglobin in fecal suspension. When gum guaiac was used, the figure was 20 mg. per cent. These sensitivities represent two to four drops of blood in 25 gm. of fecal specimen.

All positive reactions with specimens from patients who did not have tumors of the colon were considered false positives whether or not blood was actually present in the specimen.

RESULTS

The incidence of false positive reactions with each reagent was determined from a control group of 2,432 patients who did not have tumors of the colon (Table I). Each positive fecal blood reaction in this group falsely challenged the negative proctosigmoidoscopy and barium enema. Twenty-five per cent of these patients had chronic or acute symptoms suggestive of possible tumor of the colon. These were: constipation, diarrhea, melena, tenesmus, abdominal pain and a change in stool caliber. From this control group, we also found that the presence of hemorrhoids at proctosigmoidoscopy did not significantly affect fecal blood test results (Table I).

TABLE II
CARCINOMAS AND ADENOMAS OF THE COLON

Test	Cancer (%)	Malignant Polyps (%)	Benign Polyps (%)
Positive benzidine.....	64	29	14
Positive gum guaiac.....	52	19	16
Suggestive symptoms....	95	48	40
Total*.....	83	21	198

* Number of patients

Eighty-three cases of carcinoma of the colon were found in this study (Table II). The benzidine fecal blood test was positive in less than two-thirds of these cases. The gum guaiac was positive in about half. These figures remained the same when asymptomatic or clinically unsuspected tumors were considered separately. Twenty-three per cent of these eighty-three cases of cancer of the colon were unsuspected. Yet 95 per cent of the patients had symptoms of recent or chronic colonic dysfunction. If such symptoms had been used as the only screening criteria for the 10,068 patients in whom these eighty-three carcinomas were found, only four cancers would have been missed.

Twenty-one cases of malignant polyps were found (Table II). Only the benzidine reaction was positive significantly more often than in the control group. Over two-thirds of these cases would have been missed by the benzidine fecal blood test. Nearly half the cases gave a history of suggestive symptoms.

In 198 cases with adenomatous polyps, neither blood test was positive more often than in our control group (Table II). Forty per cent of these cases had symptoms suggestive of possible colonic tumors.

COMMENTS

All fecal blood tests were performed in a laboratory established for this purpose only. The same personnel performed all tests. There-

fore, we believe that our method is quite reliable. In spite of this, over one-third of the patients with cancer of the colon had a negative fecal blood reaction by our method.

These results and those of many others strongly suggest that any fecal blood test which is positive in less than 33 per cent of normal patients will miss a significant number of patients with cancer of the colon. This must mean that a random fecal specimen from any patient with cancer of the colon may contain so little blood that a practical fecal blood screening test will not detect it.

If this is true, testing two random fecal specimens for blood should increase the accuracy of detection. In our study twenty-four cases of cancer of the colon had two specimens examined for blood. In eight of these, only one of the two specimens was positive. In three cases both were negative. Therefore, doubling the number of stools routinely examined probably would increase the accuracy of the benzidine fecal blood test. However, this would double the burden on already overtaxed clinical laboratories, and over 10 per cent of patients with cancer would still be undiagnosed by this test.

Our fecal blood tests were of no value in detecting benign adenomas. Testing two stool samples was of little value. Of the forty-five patients with polyps who had two specimens tested, ten had only one stool positive for blood. None of the forty-five had positive reactions with both stool specimens. By routinely testing two stools, we would detect only 25 per cent of all benign polyps. It seems unlikely that fecal blood tests will be of value in screening for adenomas of the colon.

In our group of twenty-one patients with malignant polyps, two-thirds (fourteen) were called *in situ* lesions by the pathologist. It is intriguing that the *in situ* lesions as a group bled more often than the invasive group. However, the number of cases involved is too small to allow conclusions to be drawn. At best, fecal blood tests have little to offer as a screening procedure for malignant colonic polyps.

Ninety-five per cent of the patients with cancer of the colon had symptoms suggestive of possible colonic tumors. Almost half of all patients with benign or malignant polyps had such symptoms. These results emphasize the value of an accurate history in the early detection of cancers and adenomas of the colon.

SUMMARY

1. A good history is more reliable than a fecal blood test for detecting tumors of the colon.

2. Benzidine hydrochloride is more accurate than gum guaiac in detecting cancers and malignant polyps in the colon.

3. Neither reagent is sufficiently accurate to screen patients for carcinomas or adenomas of the colon.

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Perforation of the Cecum from Obstructing Carcinoma of the Distal Colon

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PERFORATION of a distended, disease-free cecum secondary to an obstructing lesion in the distal colon was originally described in 1880 by Heschl who referred to it as "diastatic" perforation [*16*]. Ravid [*11*] collected a total of eighty-one cases from the literature in 1951.

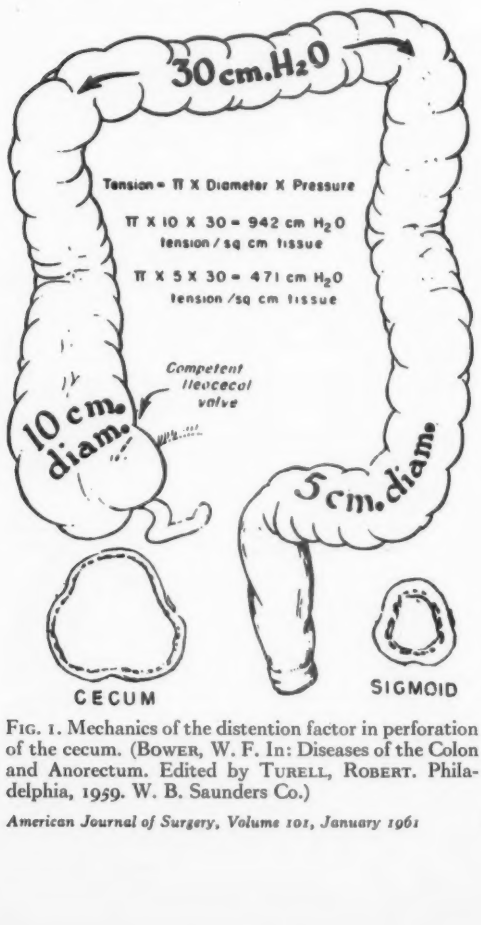


FIG. 1. Mechanics of the distention factor in perforation of the cecum. (BOWER, W. F. In: Diseases of the Colon and Anorectum. Edited by TURELL, ROBERT. Philadelphia, 1959. W. B. Saunders Co.)

Of all carcinomas of the colon treated in any series, complete obstruction occurs in 5 to 35 per cent as reported by Dennis [*2*]. In his own series of 367 cases, there were thirty-five who required decompression, an incidence of 9.5 per cent. In one instance the cecum perforated at the time of surgery. Other reports including our own show a similar low incidence, less than 5 per cent of the cases obstructed.

The pathogenesis of perforation of the cecum depends on several factors. The presence of a slowly growing tumor first creates a stenosis with partial obstruction which is followed by hypertrophy of the musculature proximal to the lesion. When complete obstruction occurs, there is a gradual rise in pressure in the colon but the cecum, which is normally the thinnest portion of the colon with a greater diameter, distends at a relatively faster rate. As the diameter increases, the circumference increases by a factor of three. (Fig. 1.) This leads to stretching and thinning. Experimentally, rapid distention alone can cause perforation of the cecum at pressures varying from 50 to 100 cm. H_2O [*17,18*]. These perforations are small, elliptical tears through the outer layers with mucosa pouting outward, and they are medial to the anterior taenia.

Some authors [*11,12*] believe that this process is all that is necessary to produce a perforation in the obstructed colon. This theory is supported clinically by finding similar tears without necrosis or gangrene. However, others [*3,9, 16*] believe that there are more important factors contributing to the perforations. It has been shown experimentally that slow distention reduces the blood supply to the bowel wall. Wangensteen [*18*] and Sperling [*14*] demonstrated that at an intraluminal pressure of 60 mm. Hg venous stasis existed and at 90 mm. Hg the arterial supply was markedly reduced.

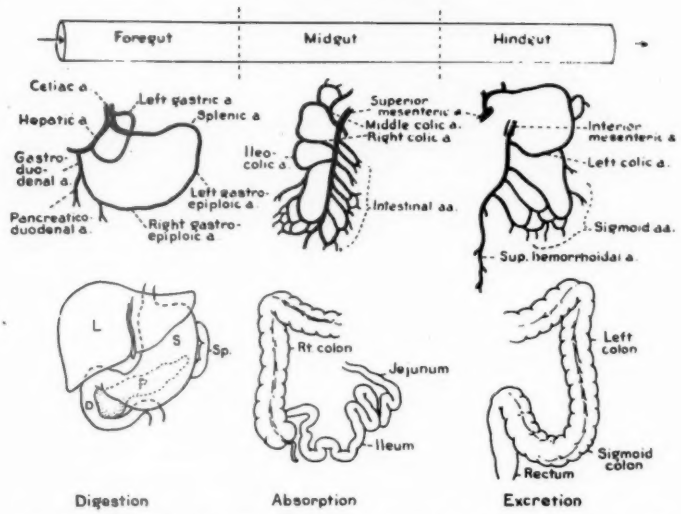


FIG. 2. Embryologic and anatomic factors in perforation of the cecum. The right colon is the terminal end of the midgut. This is the absorptive portion of the intestinal canal. The musculature is thin and readily distended. The left colon is the hindgut. This is the motor organ designed to store and expel the unabsorbed residue. The musculature is well developed and with gradually increasing occlusion in the lumen hypertrophy of the musculature takes place.

Further, the importance of the elapsed time was demonstrated by showing that even 10 cm. of sustained water pressure caused petechial hemorrhages of the mucosa, 20 cm. caused necrosis and gangrene in twenty-eight to thirty-two hours, and 40 cm. caused gangrene in seventeen to twenty hours.

Clinically, pressures measured at the time of colostomy for acute colonic obstruction varied from 12 to 52 cm. H_2O and the majority were above 23 cm. These pressures are well within the range which produced necrosis experimentally. They are also considerably lower than those pressures which produced perforation in isolated specimens by rapid mechanical distention alone.

Both types of perforations are described in case reports, so that both factors probably act simultaneously. The rate at which the pressure rises probably determines the type of perforation. It was noted from our review of the literature and in our own cases, that the gangrenous perforations are considerably more common. These also were medial to the anterior taenia, and varied in size from a few millimeters to areas of gangrene measuring 1 cm. or larger. All agree, however, that the cecum need not have any previous pathologic change.

The ileocecal valve plays an important role in determining whether or not a perforation occurs. If it is incompetent, the rising pressure in the colon is transmitted to the small bowel. If competent, it remains closed although pressures rise high enough to perforate the cecum, as shown by Wakefield and Friedell [*17*]. Estimates of the incidence of incompetency of this valve are placed as high as 90 per cent [*5, 13*]. This would explain, at least in part, the relative rarity of cecal perforations.

The perforations most commonly occur secondary to lesions of the left colon; over 50 per cent of the primary tumors are in the rectosigmoid area [*11*]. (Fig. 2.)

CLINICAL

The patients are rarely under sixty years of age, there is no particular sex or racial predilection, and evidence of chronic as well as acute illness often is present [*7,8,15,19*].

The most common complaint noted is constipation which is usually quite marked and present for several months with obstipation for periods of two to twelve days. Colicky pain referred to the right lower quadrant of the abdomen is a frequent complaint. This may lead

to the diagnosis of unrelated diseases including acute and recurrent appendicitis. Abdominal distention follows in proportion to the completeness and duration of obstruction. Vomiting is not uncommon but is never as severe as that associated with obstruction of the small bowel, and only rarely is it of a fecal character. Usually it is considered to be of reflex origin. At the time of perforation there is usually no such dramatic change as noted with a perforated peptic ulcer.

On examination soon after perforation the most striking feature may be the lack of positive findings. The temperature may be slightly elevated. The abdomen is distended and tympanic but may have very little tenderness or rigidity. The bowel sounds may still be present or even hyperactive with peristalsis visible through the tense abdominal wall. The physical condition of the patient deteriorates rapidly, however, and the signs of diffuse peritonitis soon become obvious.

Examination of the abdomen usually reveals distension of the colon to the point of obstruction. Unfortunately, free air in the peritoneal cavity is present in only 30 to 40 per cent of the cases [*1*]. In its absence perforation may be overlooked or not considered. The cecum is rarely deflated even when there is free air in the peritoneal cavity. Distention and flatus in the small bowel are not constant and indicate either incompetency of the ileocecal valve or paralytic ileus when present. Early absence of flatus in the small bowel, however, does indicate competence of the valve, and the likelihood of a perforation is increased. Measurement of the size of the cecum is used as an index of imminence of perforation [*5*]. In a series of 100 unobstructed colons, the cecum was distended with barium and air under roentgenographic control to diameters of 3 to 10.5 cm. A diameter of 9 cm. was thought to be the normal upper limit of safety. In a series of nineteen acutely obstructed colons, the cecal measurements varied from 9 to 16.3 cm. All of seven with perforation measured over 9 cm., and four were over 11 cm. in diameter.

Barium enema studies of the colon and proctoscopy are extremely valuable in showing the exact site of the obstructing lesion. A definitive diagnosis can thus be made without an abdominal exploration. Abdominal exploration is mentioned repeatedly as increasing the mortality.

MORTALITY

The mortality in this condition is quite high and is noted to be 70 to 80 per cent in various series [*1,5,11,17*] and in our own cases. This high mortality is due to the advanced age of the patients with associated physiologic derangements involving the cardiovascular, hepatorenal, and pulmonary systems. In addition, the neoplastic process has been present long enough to cause depletion of nutrition, alteration in the electrolyte and fluid balance, and reduction of the hemoglobin levels. The development of peritonitis becomes a fatal complication.

These physiologic handicaps are not insurmountable in elective surgery, but when the vascular supply of the bowel is threatened, there is no time to replace protein, carbohydrate, and blood deficits. Many of these patients tend to seek treatment long after their first symptoms have appeared.

The mortality can be reduced from a preventive standpoint by earlier diagnosis and treatment of carcinoma of the colon. It must be kept in mind that, in addition to the usual and well known symptoms commonly associated with this disease, many patients with partial obstruction in the left colon will have symptoms referable to the right side of the abdomen.

When complete obstruction occurs, accurate diagnosis must be made and treatment must be initiated promptly. Too often, conservative treatment is given for too long without a definite diagnosis.

It must also be kept in mind that perforation has been noted to occur after performance of a colostomy [*4,6,20*] and after an obstructing rectal lesion has been bypassed with a large tube. [*1*].

When perforation is obvious, exteriorization of the cecum is the treatment of choice. Mention has been made of suturing the perforation and establishing a transverse colostomy. It is unsafe to suture bowel which has an impaired blood supply.

Cecostomy has been practiced as a means of relieving colonic obstruction since 1783. The indications for its use have become clearer, but misunderstanding still exists concerning the cecostomy made for decompression of markedly distended large bowel and the cecostomy made to prevent distention in the colon. In the former it is necessary to exteriorize the cecum to permit a free evacuation of the bowel content. In the

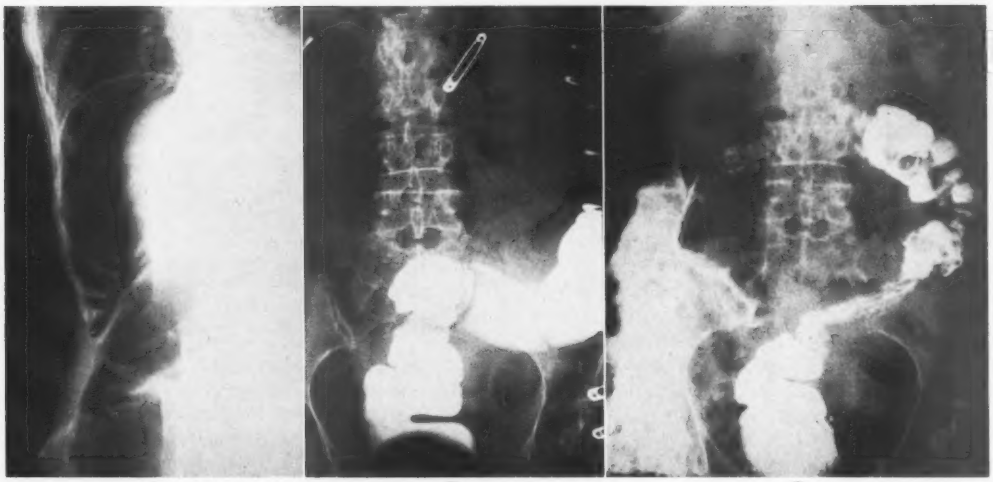
TABLE I

OBSTRUCTING CARCINOMA OF COLON FOLLOWED BY CECAL PERFORATION AND GANGRENE

Case	Sex, Age	Constipation	Distention	Rectal Bleeding	Weight Loss (lbs.)	Temperature	Pulse	Blood Pressure	Site of Lesion	Treatment	Result
1	F,47	2*	+	+	10	98.8	98	140/90	Carcinoma of hepatic flexure, perforation and abscess at cecum	Right hemicolectomy	Died four months later of metastases
2	M,74	3*	+	+	0	102.8	120	80/50	Carcinoma of sigmoid, gangrene of cecum and peritonitis	Cecostomy	Died eight hours postoperatively
3	M,57	6*	+	+	0	100.0	100	140/90	Carcinoma of hepatic flexure, gangrene of cecum and peritonitis	Obstructive resection	Died three days postoperatively
4	M,79		+	+	20	100.8			Carcinoma of hepatic flexure and gangrene of cecum	Cecostomy	Died three days postoperatively
5	F,72	3*	+	+	45	100.0	120	120/70	Carcinoma of rectum, gangrene of cecum and peritonitis	Cecostomy	Died three days postoperatively
6	F,75	7*	+	+	20	100.0	112	100/60	Carcinoma of sigmoid, gangrene of cecum and peritonitis	Cecostomy, left colon removed four weeks later	Died fourteen days postoperatively, autopsy showed pulmonary embolus
7	F,83	3†	+	+	2	102.4	140	70/50	Carcinoma of descending colon, gangrene of cecum and peritonitis	Cecostomy, left colon removed eight weeks later, cecum closed two weeks postoperatively	Discharged from hospital two weeks after closure of cecostomy

* Number of months

† Number of days



A B C

FIG. 3. A patient (Case 7) who survived the immediate effects of perforation and peritonitis, withstood removal of the left colon and closure of the cecostomy, and recovered. A, pneumoperitoneum following perforation of the cecum. B, barium enema discloses site of complete obstruction. C, barium escaped from the cecostomy following left hemicolectomy.

latter instance the cecostomy is made with a tube in the cecum without exteriorization of the bowel.

When perforation of a distended cecum has occurred, exteriorization of the perforated bowel must be performed. The tube cecostomy should be restricted in its use. The indication for its use is as a prophylactic measure to prevent distention in the large bowel.

Data for seven patients with gangrene or perforation of the cecum secondary to an obstructing carcinoma of the colon are presented in Table 1. Two of these survived the immediate condition following cecostomy. One died from a pulmonary embolus two weeks following a left hemicolectomy which had been performed four weeks after cecostomy. One survived cecostomy, resection of the left colon and closure of the cecostomy. (Figs. 3A, B and C.) A third patient survived a right hemicolectomy but died four months later from extensive disease noted at the time of the initial operation.

SUMMARY

1. The literature is reviewed and shows that these cases are relatively uncommon but that the mortality is extremely high.

2. The pathogenesis, clinical features, diagnosis, and treatment are discussed.

3. Early diagnosis of carcinoma of the colon and proper treatment of acute obstruction of the colon is important in preventing the complication of cecal perforation with its attendant high mortality.

4. The need for awareness of the possibility or imminence of perforation and indications for immediate decompression of the distended colon are emphasized.

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Use of the Left Colon to Replace the Esophagus

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One of the most discouraging aspects of the surgical treatment of carcinoma of the esophagus and gastric cardia is the extensive submucosal lymphatic involvement which is present beyond the gross confines of the tumor [12]. This residual submucosal involvement, after apparently adequate resection, has been incriminated as a major cause of recurrent malignant obstruction and has stimulated an effort toward more extensive resections. Some surgeons believe that the only adequate therapy for squamous cell carcinoma of the esophagus is a total thoracic esophagectomy [18]. Consequently, a satisfactory method for replacing the entire esophagus is needed.

Stomach [5] or tubes formed from stomach [9], segments of jejunum [19], skin tubes [4], and tubes of plastic and other inert materials [3,7] have all been used in an attempt to reconstruct the esophagus. Each has distinct disadvantages. Difficulty in mobilization [19], inadequate blood supply [19], peptic esophagitis [11], the need for multiple operations [8], and the formation of strictures and fistulas [8] have been encountered.

One of the most successful methods of esophagoplasty has made use of the colon. In most instances, segments of the right colon have been used. Colon has the advantage of being relatively resistant to gastric secretions [16]. It is nourished by a marginal artery which, in most instances, runs uninterrupted along its entire length.

Successful transplants using the right colon in antethoracic, intrathoracic and retrosternal positions have been reported [8,10,13,15], but little information regarding the use of the left colon for esophagoplasty is available.

EXPERIMENTAL STUDIES

In order to determine whether the left colon would be anatomically suitable for use as a replacement for the resected esophagus, a study of the length and blood supply of this portion of the bowel was undertaken [2]. In this study the colons of twenty fresh autopsy specimens from patients of thirty-five to eighty years of age were examined. First, the anatomy and blood supply of the colon were studied *in situ*. The entire colon was then mobilized by dividing its peritoneal attachments. All colic vessels except the middle colic artery were ligated and divided, the mesentery was trimmed from the bowel, and the terminal ileum and lower sigmoid were transected. This left the colon suspended on a pedicle containing the middle colic vessels. Each end of the mobilized colon was brought up to the chin in order to determine the length of right and left colon which might be used in reconstructing the esophagus. The middle colic artery was then divided and injected with the radiopaque barium-gelatin mixture described by Schlesinger [14]. The vascular supply of colon could then be clearly demonstrated by roentgenograms of the specimen. (Fig. 1.)

Measurements taken along the mesenteric border of the various segments of colon agreed generally with those quoted in standard anatomy texts [6]. In ten instances a segment consisting of the left half of the transverse colon and the descending colon was of adequate length to reach to the chin. In the remaining

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ten cases it was necessary to include a small portion (usually about 3 to 4 cm.) of the sigmoid colon in order to provide the additional length to reach to the chin. In no case was it necessary to use a portion of sigmoid which extended below the level of the second sigmoid artery. In four cases the right colon (right half of the transverse colon, ascending colon and cecum, but not the ileum) would not reach to the chin.

Because the viability of the grafted segment depends entirely upon blood which it receives from the marginal artery by way of the middle colic vessel, particular attention was focused on these arteries. The marginal artery was intact in all twenty specimens. (Other workers [17] report a lack of continuity in up to 5 per cent of specimens, but this is nearly always on the right side of the colon.) A substantial middle colic artery was present in all specimens. (In other series [17] its complete absence was noted in up to 5 per cent of cases.) Several variations in the number and arrangement of the colic vessels were seen, but none of them would prohibit the use of the middle colic artery as a vascular supply to the segment of colon to be used as a transplant.

From this experimental study it was concluded that the left colon transplant offers many advantages not obtained with other methods of esophagoplasty. Use of the left colon is superior to methods which employ the right colon because of its greater length and more constant blood supply. In addition, the diameter of the descending colon more nearly approximates the diameter of the esophagus than does the cecum. The greater length of this segment allows the esophagocolic anastomosis to lie high in the neck rather than within the chest. This is of value in the treatment of certain benign strictures of the esophagus and also for the bypass of inoperable neoplasms when it may be undesirable to open the chest. The development of a leak at the site of anastomosis is not as serious a complication with a cervical esophagocolostomy as it would be with an intrathoracic anastomosis.

FIG. 1. The middle colic artery has been injected with radiopaque barium-gelatin mixture. The marginal artery is clearly demonstrated. In this specimen, two middle colic arteries (M.C.A.) and three left colic arteries (L.) are present. The first sigmoid artery is indicated (S_1).

OPERATIVE TECHNIC

The variation of technic of left colon esophagoplasty which is selected depends upon the lesion and the amount of esophagus to be resected or bypassed. In patients with primary carcinoma of the esophagus, or in those with congenital atresia in whom the entire thoracic esophagus is to be bypassed, the procedure is performed in multiple stages. The first stage involves the placement of the colonic loop, with cologastrostomy and coloesophagostomy. It is vital to establish the absence of any disease of the left colon before surgery. In the presence of a colonic carcinoma, diverticulitis, colitis, or polyposis, this segment of bowel cannot be used, and another method of esophagoplasty must be selected.

The patient is placed on the operating table in the supine position with the neck extended. The entire chest, abdomen and neck are prepared and draped. The abdominal cavity is entered through a left paramedian incision. The omentum is separated from the transverse colon, and the entire left colon, splenic flexure and transverse colon are mobilized. The blood supply to the colon is visualized with particular attention to the distribution of the middle colic artery. Bulldog clamps are placed across the inferior mesenteric artery and across the com-

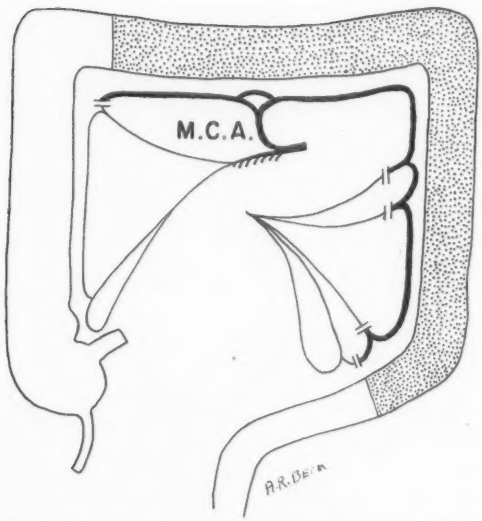

FIG. 2. Vascular pattern of the colon as encountered at operation (case A. A.). The shaded area represents the amount of colon available as a graft. The right and left colic arteries, and first sigmoid artery have been divided. The viability of the transplanted colonic segment is entirely dependent on blood which it receives from the middle colic artery.

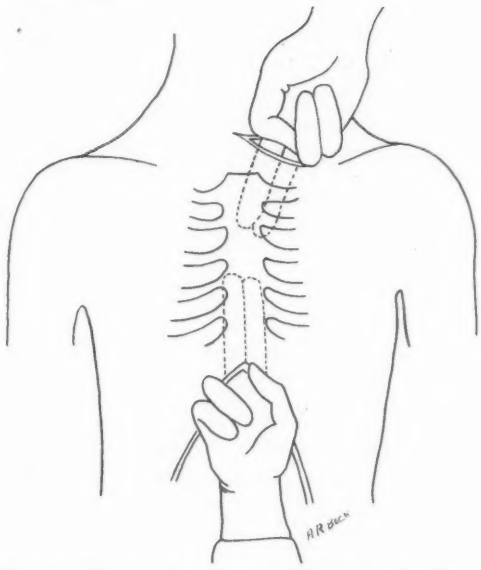

FIG. 3. The retrosternal tunnel is created by blunt dissection.

municating branches of the left and right colic arteries at the proposed sites of transection of the bowel. The adequacy of the blood supply which comes exclusively from the middle colic vessels to the transverse and left colon can then be ascertained. The bowel is divided just distal to the hepatic flexure and just distal to the first sigmoid artery, and an end-to-end colocolostomy is effected. The left and right colic arteries and the first sigmoid artery are divided, thereby leaving the transverse and descending colon free on a pedicle which contains the middle colic vessels. (Fig. 2.)

By this time, a second team has made a transverse collar incision 1 inch above the jugular notch with a vertical extension along the anterior border of the left sternocleidomastoid. The inferior thyroid artery is divided, and the inferior pole of the thyroid is retracted medially. The cervical esophagus is isolated and transected. The distal cut end is oversewn and allowed to retract into the posterior mediastinum. A retrosternal tunnel is then created by blunt dissection from above and below using the fingers and a stick sponge. (Fig. 3.)

The isolated colonic segment is brought through this tunnel in an antiperistaltic position. A two layer coloesophagostomy is performed using No. 3-0 chromic catgut for the inner layer of interrupted sutures and No. 4-0 interrupted silk sutures for the outer layer. (Fig. 4.) A cologastrostomy is performed on the anterior gastric wall midway between the greater and lesser curvature and about halfway between the cardia and the pylorus. This position prevents angulation at the lower end of the isolated colonic loop. A pyloroplasty of the Heineke-Mikulitz type is performed, and a tube gastrostomy is sewn in place. The abdominal wound is then closed and the first stage is completed. (Fig. 5.) If the lesion is not resectable, no further surgery is performed, and x-ray therapy is begun. For resectable carcinoma of the esophagus, radiotherapy is given to the thoracic esophagus starting one week after the first stage of surgery. Six weeks later the second stage, which consists of a total thoracic esophagectomy, is performed through an incision in the right side of the chest.

In cases of carcinoma of the gastric cardia, a one stage procedure is performed. Through a left thoracoabdominal incision, the proximal three-quarters of the stomach, distal one-third of the esophagus, spleen and appropriate node-bearing areas are removed *en bloc*. The colonic segment is mobilized, as previously described

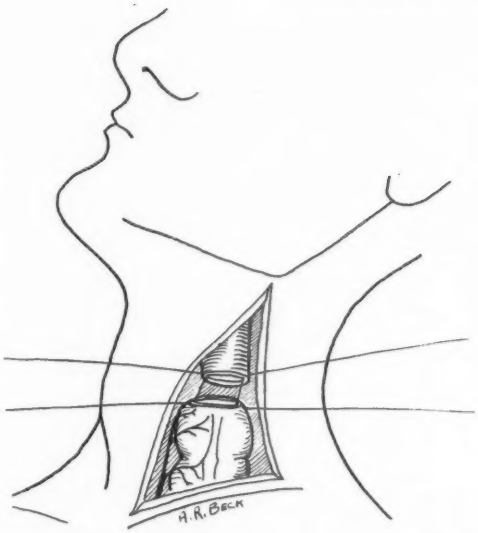

FIG. 4. A two layer end-to-end esophagocolostomy is fashioned in the neck. This can be performed by a second operating team.

and placed into the left chest in an antiperistaltic position through the site of the former esophageal hiatus. A cologastrostomy and thoracic esophagocolostomy are performed [*1*].

CLINICAL MATERIAL

During the period from July 1956 to June 1960, colonic bypass of the esophagus and/or gastric cardia was performed in seven patients. The details of these cases are presented in Table 1. It should be noted that the age range of the patients was from ten months to seventy-five years. The indications for the procedures included congenital atresia of the esophagus, adenocarcinoma of the gastric cardia, and squamous cell carcinoma of the thoracic esophagus.

COMMENTS

Certain lesions of the esophagus pose particularly difficult problems in management because they require either bypass or replacement of the entire thoracic esophagus. These conditions include squamous cell carcinoma of the esophagus, recurrent carcinoma after esophagogastric resection, and congenital atresia of the esophagus with a long atretic segment.

In primary squamous cell carcinoma of the esophagus, the results have been poor because

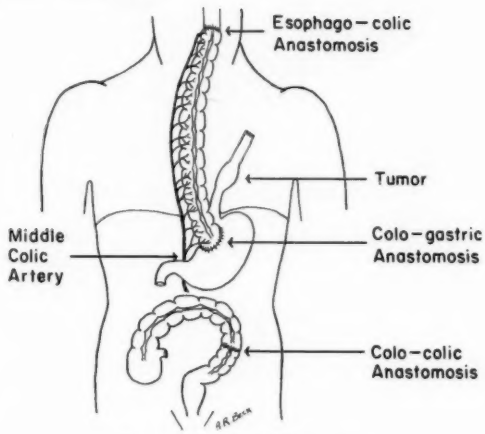

FIG. 5. Completed first stage.

of the high incidence of recurrence after resection. This recurrence is probably the result of residual carcinoma in the submucosal lymphatics rather than the result of implantation of carcinoma cells at the suture line [*18*]. It becomes apparent, therefore, that an improvement in the results in this type of surgery is dependent upon the removal of the entire thoracic esophagus. For such a purpose, the availability of a long segment of colon to replace the esophagus is a great advantage. It is particularly useful because it permits a staging of the procedure, that is, the colonic bypass may be established and a state of adequate nutrition restored before the transpleural thoracic esophagectomy is undertaken. If the carcinoma is found to be unresectable at the time of the second operation when a thoracotomy is performed, an effective bypass is already in place obviating the need for an extended surgical procedure at this time. When an esophageal carcinoma is found to be unresectable before surgery or there is recurrence after resection, a retrosternally placed colonic segment will act as a simple conduit for food without the necessity of entering the pleural cavity or transecting the diaphragm.

An interesting application of the replacement of the thoracic esophagus is seen in one patient (C. A., Table 1) who had a long atretic segment of esophagus without a tracheoesophageal fistula which was managed by a staged procedure. The danger of aspiration was avoided by the formation of a cervical esophagostomy, and the infant's nutrition was maintained by means

TABLE 1

SUMMARY OF CASES OF LEFT COLONIC ESOPHAGOPLASTY

Patient	Age	Lesion	Procedures	Status
V. S.	59 yrs.	Squamous cell carcinoma of middle third of esophagus	Total thoracic esophagectomy and intrapleural left colon transplant	Well one year post-resection; gained forty pounds
A. A.	75 yrs.	Recurrent adenocarcinoma of stomach	Esophagogastric resection and esophagogastrostomy for lesion of cardia one year earlier Left colon transplant (retrosternal) Pyloroplasty	Died eight days postoperatively from anaphylactic reaction to medication; postmortem revealed colon transplant and suture lines intact and massive obstructing recurrence at suture line of esophagogastrostomy
C. A.	10 months	Congenital esophageal atresia without fistula	Cervical esophagostomy and gastrostomy at four days of age Left colon transplant (retrosternal) Pyloroplasty	Well six weeks postoperative; gaining weight
C. N.	69 yrs.	Adenocarcinoma of gastric cardia with submucous extension into lower esophagus	*En bloc* proximal subtotal gastrectomy, subtotal esophagectomy, splenectomy and node dissection Transpleural left colon transplant Pyloroplasty	Well three months postoperatively; gained fourteen pounds
R. S.	40 yrs.	1. Squamous cell carcinoma of esophagus with perforation into posterior mediastinum 2. Chronic lung abscess	Left colon bypass of thoracic esophagus (retrosternal)	Died eleven days postoperatively. Postmortem revealed diffuse bronchopneumonia, a large tumor of middle third of esophagus with posterior perforation into mediastinum, chronic lung abscess, and an intact colonic transplant
T. K.	59 yrs.	Squamous cell carcinoma of middle third of esophagus	Left colon transplant (retrosternal) to neck in two stages. Gastrostomy and pyloroplasty Radiotherapy	Well two weeks postoperatively
H. S.	60 yrs.	Scirrhous carcinoma of stomach	Total gastrectomy, distal esophagectomy and splenectomy. Transpleural left colon replacement with esophagocolostomy and coloduodenostomy.	Well four weeks postoperatively; gaining weight

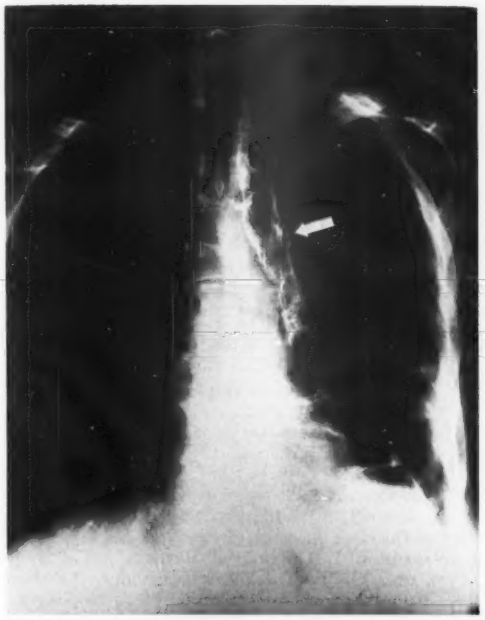

FIG. 6. V. S. Barium swallow ten months after left colon esophagoplasty and resection of a squamous cell carcinoma of the middle third of the esophagus. There is no delay in the passage of the swallowed barium (arrow).

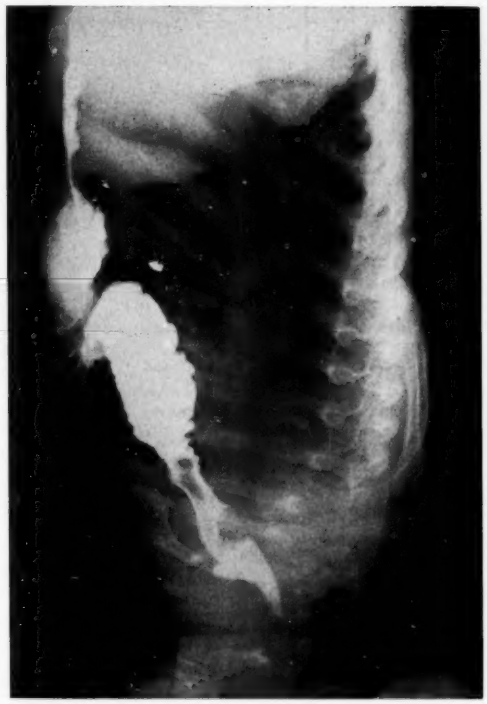

FIG. 7. Case 3. P. A. Barium swallow six weeks after a retrosternal left colon bypass in a ten month old child with congenital atresia of the esophagus.

of a gastrostomy until he was old enough to withstand the definitive surgical procedure. The well functioning passageway which was afforded by the use of a colonic segment is demonstrated in Figure 7 which represents a roentgenogram taken four weeks after completion of the bypass procedure. The retrosternal placement of the colon avoids the cosmetic disturbance associated with an antethoracic subcutaneous bypass.

Because of its anatomic proximity, the transverse and left colon is particularly useful where the esophagogastric junction and distal esophagus must be replaced or bypassed. Such a situation may exist in lye stricture, peptic esophagitis with stricture, and portal hypertension when porto-systemic shunts are not possible and the portion containing varices must be excised.

SUMMARY

1. An experimental study on the use of the left colon as a replacement for the thoracic esophagus is presented. Emphasis is placed on the adequacy of the length of bowel and the vascular supply. The left colon is superior to the right for esophageal replacement because a greater length is available, it is more nearly the same diameter as the esophagus, and its marginal artery is more consistent.

2. Technics are described for the clinical application of left colonic bypass of the esophagus.

3. Seven cases in which left colonic bypass of the esophagus or gastric cardia is utilized are described.

ADDENDUM

The present status of the five patients who still survived at the time of the original report is as follows: V. S. is well and maintaining weight nineteen months after resection. There is no evidence of recurrent disease. C. A. is well and gaining weight seven months after operation. C. N. is well and maintaining weight ten months after surgery. T. K. died six months after surgery. The primary lesion was not re-

sected. H. S. is well eight months after operation.

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Experience with the Use of the Right Colon to Replace the Esophagus

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THE operation for removal of the middle third of the esophagus for either benign or malignant disease must provide for resection of the esophagus and be followed by either a direct anastomosis between the mobilized stomach and the cervical esophagus, or by an esophageal substitute. Many surgeons now prefer to replace the thoracic esophagus with the right colon.

This presentation is a review of our application of this technic and experience with twenty-two patients; fourteen had carcinoma, two had lye stricture, two had advanced cardiospasm, two had congenital atresia of the esophagus, and two had esophageal varices.

MORTALITY

There were three immediate postoperative deaths making a mortality of 13.5 per cent. One of these followed the first stage and was due to an abscess of the superior mediastinum. The other two were following the second stage and were due to gangrene of the colonic segment. There have been two late deaths due to recurrent carcinoma. Four patients are alive with evidence of carcinoma. Five patients are alive with no demonstrable carcinoma. However, the longest postoperative survival is only two years, so such figures are of little value.

These operations are of very great magnitude and would present considerable risk even to healthy patients. However, none of the patients who need this procedure is in good condition. They are usually in an advanced state of malnutrition. Caloric, protein and vitamin deficiencies are present. Reversal from negative to positive nitrogen balance must be accomplished before the patients are operated upon.

PROCEDURE

Preoperative preparation. It is essential that these patients be given as much nourishment as possible and that a record be kept so that a daily intake minimum is assured. This should be computed carefully and measured to contain 3,000 calories with no less than 150 to 200 gm. of protein and a deliberate oversupply of all the essential vitamins (1,000 mg. of vitamin C, 10 to 20 mg. of vitamin K, and double the daily requirement of vitamin B complex). This can be prepared as 3,000 cc. of liquid for patients who are unable to swallow solid food, and a nasogastric feeding tube with a small lumen may be inserted to administer the fluid. In extreme cases feedings may have to be given through a preliminary gastrostomy (performed under local anesthesia). If the diet is composed of regularly taken foods which have been processed in a blender, and it is not composed of synthesized or partially digested proteins, troublesome diarrhea will be avoided. The Barron Food Pump* greatly facilitates the administration of tube or gastrostomy feedings. A constant rate of flow can be maintained mechanically throughout the twenty-four hour period. The slow rate of flow also improves absorption.

It is important that positive nitrogen balance be in effect for three weeks before surgery is attempted. After this regimen is established, patients will usually experience an almost immediate improvement in their feeling of well-being and often will press the surgeon to proceed at once with the resection. The referring physician may think that three weeks is too long to wait, especially in the presence of a cancer. However, the surgeon should adamantly insist upon the restoration of good

* Barron Food Pump, Randolph Surgical Co., Detroit, Michigan.

nutrition, as measured by some gain in weight, before attempting the surgical procedure. Three weeks has been the usual time required to attain this aim.

The usual preoperative assessment of renal, hepatic, cardiac and respiratory reserves are made, and the patient is given transfusions of whole blood to levels of not less than 14 mg. per cent of hemoglobin.

First Stage. The primary tumor together with the carcinoma-bearing tissues are extirpated during this stage, a cutaneous esophageal fistula is established and a gastrostomy is performed for feeding if this has not been done before.

A right thoracotomy usually provides best access to the lesion and facilitates the dissection. These lesions are often intimately associated with the trachea and aorta. When there is some adherence of the lesion to the mediastinal structures, the difference between a tumor which is "removable" and one which is "unremovable" may well be determined by the side through which it has been approached. The entire thoracic esophagus is mobilized between the entrance from the neck to its egress through the diaphragm. Although we have customarily observed Cole's [1] admonition to place occlusive tape ties on the esophagus at some distance above and below the level of the carcinoma, these can be applied only after resectability has been established which is often after considerable dissection and manipulation of the tumor. The cervical end of the esophagus is then divided as high as possible leaving no more than 6 to 8 cm. of esophagus from the level of the hypopharynx. Since the colon can readily be brought up to above the level of the clavicle, there is no need to preserve more than 6 to 8 cm. of the upper end. This is important because of the known tendency of these tumors for submucosal extension. The lower end is then divided and inverted at the level of the diaphragm. The chest is closed, and two tubes are inserted for closed drainage.

A right transverse incision is made in the neck, a small portion of the anterior sterno cleidomastoid muscle is divided, and the end of the cervical esophagus is brought out. Interrupted silk sutures are used to approximate the skin and esophageal mucosa around its circumference. We aim to exteriorize the cervical segment medial to the great vessels since we believe that the eventual deglutitory mechanism will be aided by the gravitational force if the reconstructed esophagus is as close to the midline as possible.

The abdominal operation should be performed through a midline incision which begins at the level of the xiphoid. The esophageal stump is separated from the diaphragm and brought down out of the chest. *A fairly generous portion of cardia and stomach, along the lesser curvature, is removed with this segment.* This should be emphasized since one of our patients returned two years after resection with a serious exsanguination from a large localized mucosal recurrence at this level. If lymph nodes are present about the celiac axis, they should be removed in an attempt at *en bloc* dissection. A gastrostomy as well as a pyloroplasty are performed at this time.

Postoperatively, attention again must be focused on maintenance of the nutritional state of the patient. Tube feedings may be administered with the Barron pump. The aim is to restore the patient physically for the second stage of the operative procedure. Weight gain, increased strength, and increased interest in the surroundings are measures of progress. The patient should feel strong enough to undergo the second procedure and be anxious that it be done. The interval between the first and second operation has varied from one to three months, depending upon the progress of the patient, but has usually been performed in six weeks.

Second stage. The colon is prepared by the administration of sulfasuxidine and a low residue diet for one week. On the day before surgery a Fleet's saline cathartic and repeated saline enemas are given. It is essential that the colon be clean. The patient is draped so that the abdomen, thorax and neck may be exposed as the procedure advances. The operation is begun by opening and enlarging the previous abdominal incision. *It is essential that the vessels of the colon be carefully protected during this and subsequent dissections.* The cecum with the terminal ileum and the entire right colon are then mobilized medially by dividing the lateral peritoneal reflexion. The right ureter is identified and separated from the mesentery of the colon. To further mobilize the colon, the hepatic flexure is freed and the colon separated from the duodenum, stomach, and omentum, to as far as the midline. The middle, right and left colic arteries and their connecting arcades and marginal vessels are surveyed so that the division of all vessels can be made as far away from the colon as possible in order to preserve

the arcade. Division of the right colic artery at its origin from the superior mesenteric vessel usually provides some mobility and this, together with the freedom provided by division of the terminal ileum, will provide ample mobility to allow the cecum to be brought to the level of the clavicle. Occasionally, there may be two middle colic vessels; the one extending toward the hepatic flexure may have to be divided to provide a sufficient length of colon.

Once the terminal ileum and the rest of the mesocolon around the middle colic artery has been divided, the cecum almost always will reach the level of the clavicle. We prefer to deliver the cecum into the neck at this time and establish the cecal-esophageal anastomosis. This allows adjustment of the segment to eliminate any tension while the abdomen is still open. One of us has preferred to use a substernal position for the cecum (fourteen cases of the present series); in other cases the cecum has been placed subcutaneously.

If the intrathoracic route is chosen, the tunnel is constructed as follows: the anterior mediastinum is opened by freeing the anterior attachment of the diaphragm from the posterior wall of the sternum by blunt dissection for a distance of about 7 to 8 cm. This will allow the dissecting hand to enter the anterior mediastinum just behind the sternum and in front of the pericardium. As the fingers of the dissecting hand advance up the anterior mediastinum, the hand readily reaches the level of the second rib, anteriorly. The pleura on both sides usually will not be torn if dissection is performed slowly and carefully.

The cervical portion of the operation is then carried out. The old incision is opened, the cervical stump is freed from its surroundings and the lines of cleavage into the mediastinum are developed. This necessitates division of both strap muscles from their attachment to the posterior surface of the sternum on both sides. They must be divided on both sides to provide sufficient room to bring the cecum up into the neck. Sometimes it may be necessary to divide both the clavicular and the sternal head of the sternocleidomastoid. After these muscles have been divided the anterior mediastinum is entered with ease and the tunnel previously opened from below will be encountered. We have found it necessary to be certain that the point at which the superior and inferior dissections meet be dissected widely and be free of any loose strands of tissue which might still connect the posterior wall of the sternum to the mediastinal structures. If the entire dissecting hand and arm is carried up from below, there will be ample room for the colon.

Care must be exercised in bringing the cecum up to the level of the neck to avoid twisting or tearing the mesentery bearing the marginal vessel. Gentle traction must be used at all times. Sutures to invert the terminal ileal stump into the cecum, if left long, may be helpful in advancing the segment up the mediastinum. One difficulty has been a tendency on the part of the operating surgeon not to open the root of the neck sufficiently. The cecum should slip readily into the neck and remain there without tension. We have meticulously avoided removing any portion of the clavicle or sternum since we have feared infection and the development of osteomyelitis.

Once the cecum lies easily in the neck, a typical three-layer anastomosis can be carried out between the head of the cecum and the proximal esophageal stump. In this way the wall of the cecum is actually brought up around the esophagus and, in a sense, encloses it. After this anastomosis has been completed, the abdominal procedure may be finished. Restoration of continuity of the colon (by ileocolostomy) and of the upper intestinal tract (by cologastrostomy) must be accomplished. These two procedures can and should be performed without dividing the marginal artery. This step is of great importance since it is the only channel for blood supply to the cecum in some cases. A gastrostomy tube has been left in place for postoperative decompression and for feeding purposes. These patients have not been given oral liquids until the seventh postoperative day.

The abdominal portion of the operation has been closed with through and through sutures. Two hollow rubber tube drains can be placed so that they go up into the opening in the anterior mediastinum and also pass by the area of the cologastric anastomosis. The operation on the neck has been closed by placing interrupted sutures which are tied after twenty-four hours. *During this time the depths of the incision in the neck can be inspected to ascertain that the colon is unmistakably viable.*

FEATURES OF USE OF THE RIGHT COLON

The use of the right colon to replace the esophagus has gained popularity because of several factors which seem advantageous. The

right colon provides a living peristaltic tube which can be removed from its location in the intestinal tract without appreciable detriment to the normal physiology of the patient. Adequate circulation at the suture line is essential if healing is to occur without leakage. The well developed marginal vessels provide a rich blood supply. The division of the right colic artery at the base of the mesentery allows mobilization of the long segment of colon from the cecum to the transverse colon. Thus, the blood supply to the cecum (which is to be used for anastomosis) is assured by careful evaluation and dissection.

The mobility obtained should provide a sufficient length of colon, without tension, to deliver and maintain the position of the cecum in the neck. Thus assured that there is sufficient colon for an anastomosis which is free of tension, the surgeon has no need for compromise on the extent of his resection of the tumor bearing portion of the esophagus.

The procedure lends itself well to a two stage operation. A debilitated patient will tolerate the shorter first stage procedure after a three week period of improvement in nutrition. The tumor is eliminated at this first stage. As much time as necessary may then be taken to improve the patient's nutrition and prepare him for the reconstructive phase which requires a longer operative session, is more hazardous and associated with more possible complications. We believe that the disadvantage of a two stage operation, with possibly a longer total hospitalization, is far outweighed by the reduction in mortality and morbidity.

Merendino [2] has observed that isolated segments of intestine placed between the esophagus and stomach were more resistant to acid peptic digestion than the esophagus itself. Esophagitis, ulceration and subsequent benign stenosis in the esophagus have been troublesome when the esophagus was anastomosed directly to the mobilized stomach. The colon has not shown these changes.

COMPLICATIONS

Several complications have occurred in our series. After the first stage of the procedure, the most serious has been the development of an *abscess in the superior mediastinum*. This occurred only once. However, it was not recognized during the early stages of its development, and this particular patient had had such marked atelectasis that a tracheotomy had been done to facilitate the tracheobronchial toilet. Obviously, our main concern had been focused on removal of retained secretions. Fluid levels of the mediastinum were finally noticed on roentgenograms, and wide drainage was established. Irrigations of the pocket were used with improvement in the infection. However, this patient developed a fistula between the lower end of this abscess cavity and the trachea and subsequently died. We have no precise ideas as to how such an abscess could be avoided in the future. The superior mediastinum had not been drained through the incision in the neck, although this incision had been only loosely closed. However, late recognition of the complication was a serious error. The position of such an abscess makes radiologic diagnosis difficult until a fluid level can be seen. *We believe that roentgenograms of the chest, taken on the third, fifth and eighth postoperative days, with special attention being directed to the superior mediastinum, might lead to earlier recognition of this complication.*

Dehydration, nitrogen retention and acidosis developed in two patients during the interval between the first and second stages. This was precipitated by the administration of feedings which were too concentrated. In both cases we were trying to compensate for nutritional deficiencies too rapidly. Both patients were receiving high protein (200 gm. per day), high calorie (3,000 per day) feedings with insufficient amounts of fluid. The initial symptoms were cerebral in both of these patients, *i.e.*, they were incoherent and irrational, and were then found to have nitrogen retention and acidosis. Both were relieved without difficulty by reducing the diet and providing voluminous quantities of water through the gastrostomy feeding tube. Exacerabation of quiescent *gout* developed in one patient.

One patient developed *chylothorax* after the first stage. This was associated with a massive loss of chyle, approximately 4,000 cc. per day. The nitrogen loss of this patient could not be controlled until operative ligation of the thoracic duct below the opening at the level of the diaphragm was accomplished. A small residual empyema cavity which required a limited rib resection developed.

The most serious complication associated with the second stage was *gangrene of the colonic segment* which occurred in four patients. Two of these patients died. In both patients, the

gangrenous segment had been recognized. One was diagnosed twenty-four hours postoperatively and the other after four days. These were removed as soon as they were diagnosed, but neither patient survived. Earlier recognition of the gangrene might have led to more prompt removal of the colonic segment and survival of the patient. In a third patient the wound in the neck was opened thirty-six hours postoperatively. The black cecal head was seen, the gangrenous segment was removed through the abdominal wound, and the patient recovered. In a fourth patient, the head of the cecum became dusky while the colon was being prepared. The dusky portion was resected and sufficient length remained for a satisfactory anastomosis.

The preservation of the blood supply to the segment is the crucial part of the operation, and we believe that all four cases of gangrene have been the result of a technical error. This error was failure to preserve all possible arcades of vessels in the mesentery. It is as important to preserve the venous return as to preserve the arterial inflow. Venous engorgement was believed to be the cause in the third patient. To repeat, for emphasis, it is imperative not only to divide the vessels at the root of the mesentery, but to preserve all possible collaterals, and especially to test the adequacy of the remaining circulation by temporary occlusion of any artery prior to its division. The color and appearance of the cecum should be examined in the neck incision repeatedly, and after the operation is completed the neck wound is not closed. Rather, the skin sutures are left untied. Every four to six hours the segment is inspected and the neck wound is closed by tying the previously placed sutures after twenty-four hours. If the segment becomes gangrenous, prompt removal may be life-saving.

A second complication following the reconstruction has been *leakage at the esophagocolic anastomosis.* Four patients had a small leak which drained promptly through the drain site in the neck incision. None of these patients died. In two cases the leak closed spontaneously and two were closed surgically. We believe that these fistulas will close unless there is distal obstruction to the flow of food or local recurrence. One fistula closed spontaneously but later reopened. It then persisted and the patient was found to have a partial obstruction of the small bowel with intermittent regurgitation. Although recurrent carcinoma was present two inches distal to the fistula, it did not obstruct the colonic segment. The bowel obstruction was the factor in the persistence of the fistula in this case.

This series is admittedly too small and the time too short to draw any conclusions as to improvement in the rate of cure with this procedure. Our early enthusiasm has been dampened somewhat by the appearance of recurrences and metastatic carcinoma in one to two years following surgery. Hoarseness developed in two patients. Left vocal cord paralysis secondary to invasion of the recurrent laryngeal nerve by tumor was found. One patient had obstruction at the level of the clavicle by recurrent tumor, necessitating re-establishment of his gastrostomy. One patient had a massive hemorrhage from recurrence with ulceration in the cardia of the stomach. This was resectable and was the only demonstrable area of recurrence. Other patients with recurrences had the typical symptoms of pain, anorexia, anemia and weight loss.

The brighter side of the picture is the late results in the patients with benign conditions. There have been no deaths in this group, and no symptoms or evidence of esophagitis. The swallowing mechanism and ability of the patient to eat has been satisfactory.

SUMMARY

1. Improvement of the nutritional state of all patients prior to any resection is the single most important preoperative step.

2. The operation should be divided into two stages, *i.e.*, the resective and the reconstructive stages.

3. The right colon provides a very satisfactory substitute for the thoracic esophagus.

4. Gangrene of the colonic segment is the most feared and serious complication. Steps to be taken in minimizing this danger are discussed.

4. The late results of treatment of benign conditions has been very satisfactory, while the appearance of recurrent and metastatic tumors in the patients with carcinoma has been discouraging.

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Defunctionalization of Colonic Anastomoses in Dogs

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OBSTRUCTION of the large bowel produced by a lesion in the left half of the colon is the most frequent indication for a loop or divided limb colostomy. Closure is frequently performed as a third stage following resection of the lesion at a second operation. A less common indication for a temporary colostomy is to protect a distal anastomosis.

When a colostomy has been performed for one of these reasons, there are differences of opinion concerning when it should be closed. In ten days to two weeks healing of an anastomosis has progressed sufficiently for return of normal bowel function. Closure at this time has advantages. From an aesthetic and psychologic viewpoint, early closure is desirable as it eliminates the problems associated with adjusting to a colostomy. Complications such as prolapse, herniation, and skin excoriation are either avoided or minimized. Cost in terms of time and money may be reduced although this is not always true.

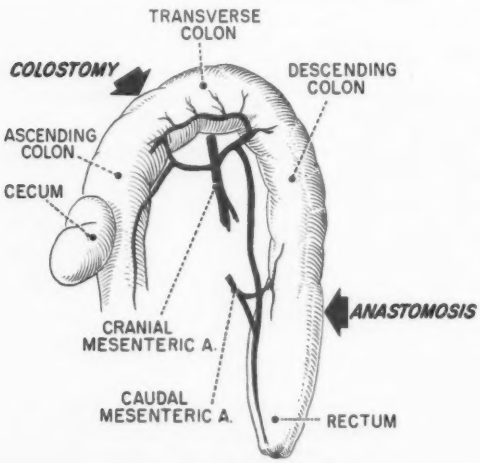

FIG. 1. The colon in the dog.

One of the most common reasons for delayed closure of the colostomy is wound infection. Many patients with a lesion of the left colon which produced intestinal obstruction necessitating colostomy are elderly, have lost weight, are hypoproteinemic and have a reduced blood volume. Hepatic, renal, cardiac, and pulmonary functions are often borderline. An interval of two to three months or longer at home, with proper nutrition, will reduce the risk entailed by closure of the colostomy. This interval is often important in permitting the psychologic rehabilitation of a patient depressed by a period of hospitalization which may have been long and complicated. A suspected leak at the anastomosis and other causes of intraperitoneal inflammation are indications for delay in the closure.

The question of whether or not prolonged defunctionalization *per se*, ultimately leads to narrowing or even stricture of the anastomosis distal to the colostomy is relevant to this decision. When the colostomy is closed in ten days or two weeks, the passage of feces acts to stretch or dilate the anastomosis during the cicatricial stages of healing. This problem was investigated in dogs.

MATERIALS AND METHODS

Unselected (animal colony) mongrel dogs of both sexes varying in weight between 7 and 12 kg. were used. The animals were purged with castor oil the afternoon before operation. Food was withdrawn the morning of surgery. No antibiotics or blood transfusions were given before or after surgery. A 2 to 4 cm. segment of the

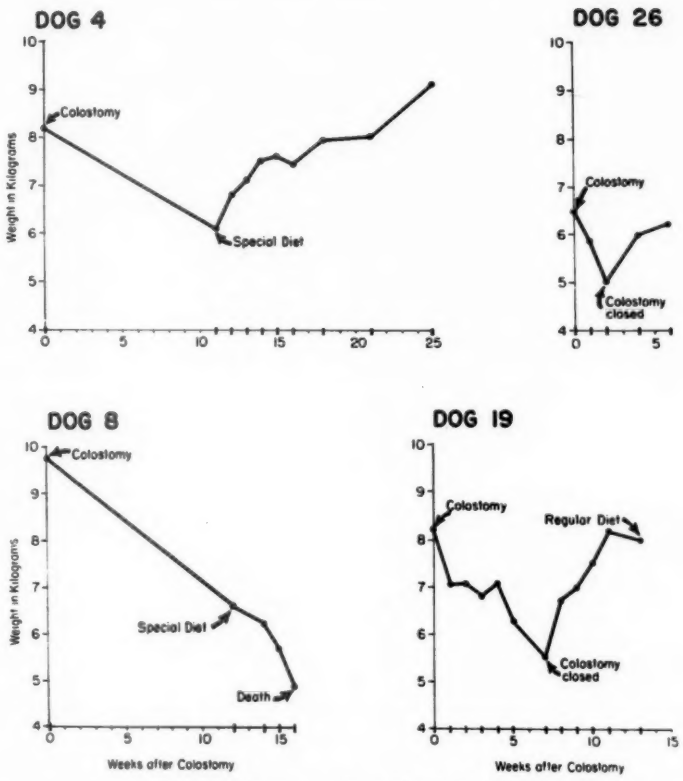

FIG. 2. Colostomy and nutrition in the dog.

distal left colon was resected. The level of the resection was as far distal in the colon as feasible for completion of an anastomosis. The anastomosis was performed in one layer, using interrupted sutures of No. 4–0 black silk placed as described by Lembert. The colostomy was established by dividing the colon at the junction of its proximal and middle one third. A dog which weighs 20 kg. has about 60 cm. of abdominal colon. (Fig. 1.) The proximal end of the colon was brought through a separate wound made by excising a circular piece of skin and fascia 1 cm. in diameter in the upper right quadrant. The end of the bowel was sutured to the adjacent skin margin with interrupted sutures of No. 4–0 plain catgut. The other end of the divided colon was brought out through the upper extension of the midline abdominal wound.

The first animals so treated were returned to their cages with no abdominal dressing. Within twenty-four to forty-eight hours of operation, two dogs died as a result of peritonitis resulting from chewing and clawing of the colostomy. Thereafter, the abdomen was incorporated in a light plaster dressing at the end of the operation. This was constructed to permit access to the functioning colostomy. However, most animals adjusted to the colostomy and it was possible to safely remove the plaster dressing in about two weeks. Male dogs did not tolerate colostomies as well as females.

Following the operation the dogs were placed on the routine diet consisting of Purina pellets and scraps of meat from the hospital dining rooms. On this regimen dogs rapidly lost weight, even though the amount of food ingested equaled or exceeded the preoperative intake; death from malnutrition was observed within two weeks of operation. Balance studies revealed increased losses of nitrogen and fat in the stool as compared with dogs without

TABLE I

Dog No.	Operation*				Anastomosis†			Fate‡				Survival (mo.)			
	1	2	3	4	5	6	7	8	9	10	11	1	1–6	6–30	30
1		X				X				X		X			
2		X				X				X		X			
3		X				X					X		X		
4		X				X		X							X
5		X			X						X		X		
6		X					X		X			X			
7		X					X		X			X			
8		X				X				X			X		
9		X			X					X		X			
10		X				X					X		X		
11	X					X		X							X
12		X					X				X		X		
13	X						X		X			X			
14		X					X		X			X			
15		X				X					X			X	
16			X			X					X			X	
17	X					X		X							X
18		X			X			X							X
19				X		X		X						X	
20				X		X		X							X
21		X				X					X		X		
22			X			X					X		X		
23		X					X		X			X			
24		X				X					X		X		
25	X				X			X							X
26				X		X		X							X
Total	4	17	2	3	4	16	6	8	5	4	9	8	8	3	7

* 1 = anastomosis; 2 = anastomosis with proximal colostomy; 3 = anastomosis and subsequent colostomy; 4 = anastomosis with proximal colostomy and subsequent closure of colostomy.

† 5 = anastomosis not seen, x-ray; 6 = anastomosis seen, no obstruction, x-ray; 7 = anastomosis, other.

‡ 8 = sacrificed or returned to dog colony; 9 = death: postoperative (within 7 days); 10 = death: malnutrition; 11 = death: unknown 5, enema 2, anastomosis breakdown 1, colostomy obstruction 1.

colostomies. No explanation other than defective assimilation of ingested food materials for this course of events, was forthcoming from close observation of the experimental animals. The weight loss could be arrested by doubling the protein and caloric intake with feedings of fortified horsemeat. However, even with further increases in feeding, dogs did not gain substantial amounts of weight following colostomy. When the colostomy was closed in two dogs who had lost more than 25 per cent of their body weight during two weeks following the colostomy, there was a return to their preoperative weight within three weeks. (Fig. 2.) The obvious conclusion is that the distal two-thirds of the colon plays a vital role in the proper utilization of food stuffs in the dog. We are unable to find records of similar observations by other workers. The discrepancy between colonic function in the human and in the dog is apparent. More elaborate investigations which include balance studies will be necessary to properly assess the meaning of these observations, and to ascertain the mechanisms involved if the findings are confirmed. All animals operated upon after these nutritional observations had been made were maintained on fortified horsemeat which supplied about two times the calculated protein and carbohydrate requirements of each animal.

Barium x-ray studies of the defunctionalized colon were made at intervals following operation until the animal was returned to the colony, sacrificed or died of another cause. Considerable variation in the amount of mucus secreted in the defunctionalized colon was ob-

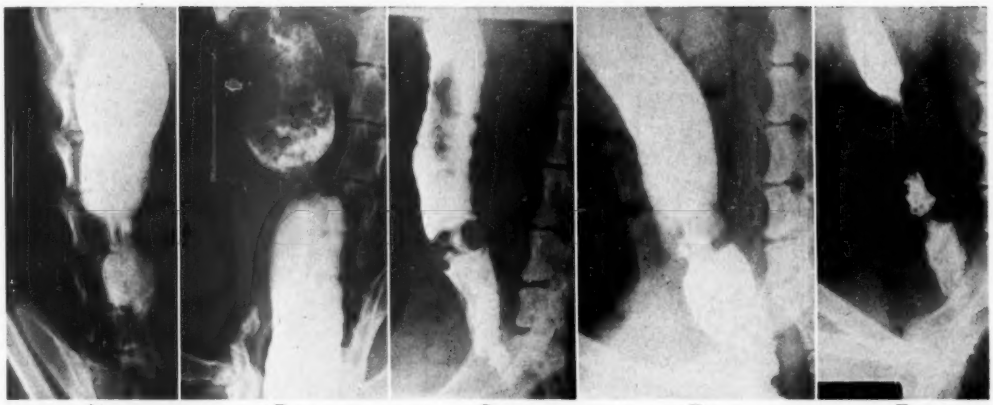

FIG. 3. Dog 11 did not have colostomy. A, two weeks postoperative; B, eight weeks postoperative; C, twenty-six weeks postoperative; D, fifty-two weeks postoperative; and E, one hundred and twelve weeks postoperative.

served. In some dogs difficulty was experienced in removing tenacious mucus with tap water enemas so that a satisfactory barium study could be made. Autopsies were performed on all animals which died during the period of observation and those sacrificed.

RESULTS

The findings observed in the twenty-six dogs are recorded in Table 1. Nine of the animals may be regarded as controls. In two of the four which had an anastomosis with no proximal colostomy (Dogs 11 and 17) the site of the anastomosis could readily be identified on barium x-ray examination for two and a half years following surgery. There was no clinical evidence of obstruction. Films from (Dog 11) the dog with the most marked findings are reproduced in Figure 3. One of the four dogs with an anastomosis only (Dog 13) was the only animal which died during the immediate postoperative period as a result of an anastomotic leak. A second type of control was provided by two animals (Dogs 16 and 22) in which the colostomy was performed six and three months, respectively, following the initial operation. In

FIG. 4. Dog 22 had resection and anastomosis and, later, colostomy. A, two weeks after the first operation; B, eight weeks after the first operation: C, two weeks after the second operation; and D, ten weeks after the second operation.

A B C D

FIG. 5. Dog 20 had anastomosis with proximal colostomy and, later, closure of colostomy. A, two weeks after the first operation; B, ten weeks after the first operation; C, two weeks after the second operation; and D, fifty weeks after the second operation.

both animals the anastomosis could be seen before and after colostomy. (Fig. 4.) Three of the animals (Dogs 19, 20, and 26) had their colostomies closed two months or longer after the anastomosis. As previously indicated this was a "life saving" procedure in Dogs 19 and 26. In all three of these animals the anastomosis, which could easily be noted before and after, did not seem to be affected by closure. (Fig. 5.)

All of the remaining dogs had proximal colostomies with distal anastomoses and may be regarded as the experimental animals. The seven which died during the first postoperative month did not survive long enough to assess the effect of defunctionalization on the anastomosis. The defunctionalized anastomosis could not be definitely located on barium x-ray examination in Dogs 5 or 18. In the latter this was true for more than two years following surgery. Two months after operation the anastomosis in Dog 12 was obstructed. At reoperation we found that the obstruction was not due to technical error but to induration with edema. Three months after resection and reanastomosis barium could not be passed through the anastomosis. Peritonitis and death followed when the defunctionalized segment was perforated in attempting to cleanse it with an enema. The anastomosis in the seven remaining dogs could be easily identified on barium x-ray examination. There was no indication that narrowing or stricture occurred at the site of the defunctionalized anastomosis in these dogs. Dogs 4 and 18 were followed for more than two and a half years. With the passage of time, there was a decrease in the caliber or diameter of the colon. (Fig. 6.) Decrease in the size of the colon in most of the animals was first noticeable about two months after the colon was defunctionalized. Observe that the anastomosis in the defunctionalized segment progressively became less prominent.

COMMENTS AND CONCLUSIONS

The indication of an essential role of the distal two-thirds of the colon in nutrition in the dog is of interest. Feces coming from the colostomy were semisolid, of usual brownish color and did not cause excoriation of the surrounding skin in most animals. This apparent difference in colonic function implies physiologic and perhaps unrecognized anatomic differences between the colon of dogs and humans. This finding has significance in the evaluation of the results of gastroenterologic studies conducted in the dog as they may apply to the human.

Anastomoses in the colon, which were de-

FIG. 6. Dog 18 had anastomosis with proximal colostomy. A, two weeks after operation; B, eight weeks after operation; C, thirty weeks after operation; D, one and a half years after operation; and E, two and a half years after operation.

functionalized for as long as two and a half years in dogs, did not become narrowed or strictured. After two to three postoperative weeks, during which the early stages of the healing process have occurred, neither barium x-ray examination nor surgical and autopsy findings revealed subsequent reduction in the size of the lumen.

Chronic Perineal Sinus Following Total Colectomy for Ulcerative Colitis

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IN a review of our patients who have been treated for ulcerative colitis by proctocolectomy, it has been observed that the perineal incision has failed to heal as rapidly as is usually expected when the rectum is removed for cancer. The perineal wound characteristically forms a sinus tract which may be only a minor annoyance in many patients who have colectomy. On the other hand, a deep, chronically infected perineal tract may represent a disability serious enough to cause repeated hospitalization for surgical treatment. Several of our patients have had six to eight admissions for surgical treatment of a persistent, chronically infected perineal sinus tract. Healing of the perineum has taken more than three months in twenty-seven of thirty-two patients.

Bacon [1] and Lahey [2] have mentioned this problem, but a review of the literature has failed to disclose any comprehensive discussion as to etiology and treatment. It is the purpose of this communication to present the magnitude of the problem in our experience and to suggest possible etiologic factors and methods of prevention and treatment.

MATERIAL

Thirty-two male patients with chronic nonspecific ulcerative colitis have been treated by proctocolectomy with ileostomy in one or more stages at the Seattle Veterans Administration Hospital from 1951 through 1959. These cases have been reviewed and all of the patients have been examined by one of us. Only patients in whom the perineum has not healed and those who have been followed up for more than one year postoperatively are included in this study. Each of these patients had been treated surgically in military or veterans' hospitals and complete records were available for review. Thirty patients underwent resection of the rectum at this hospital.

RESULTS

Preoperative Factors

Age. Tables I and II demonstrate that age had no effect on the rate of healing. Most of these patients were young men. The perineum healed in three patients who were over fifty years of age at the time of proctectomy in 11, 12 and 24 months respectively. Healing of the perineum occurred within three months postoperatively in three patients but failed to occur in nine patients after more than three years. These two groups represent the extremes of healing time and the remaining rates varied between three and thirty-six months. (Table III.)

Duration of Ulcerative Colitis Before Colectomy. All of the operative specimens have been diagnosed by the pathologist as severe, chronic, nonspecific ulcerative colitis. The history of these patients has been reviewed to determine the duration of ulcerative colitis before colectomy was performed. The extremes of healing time are examined again in Tables I and II. It is obvious that in this series of cases the presence of either the acute fulminant or chronic ulcerative colitis of many years' duration did not affect the rate of healing of the perineal wound.

Cortisone and ACTH. The dosage of cortisone and ACTH used in treatment of these patients during the three months preceding and the month following proctocolectomy was reviewed to observe the influence on healing of the perineal wound. Table I shows the total

TABLE I
PERINEAL HEALING WITHIN THREE MONTHS

Patient	Age	No. of Months Before Healing	Duration Before Surgery	ACTH	Cortisone
D. R.	28	3	3 years	80 U.	
J. R.	27	2	9 years		
E. H.	32	1	10 years		700 mg.

amount of cortisone and ACTH used in treating those patients healing in three months or less. Table II records the amount of cortisone and ACTH administered to patients in whom perineal healing was not complete for over 36 months. It is apparent that the amount of steroids or corticotrophin used immediately preoperatively and postoperatively had little to do with ultimate healing of the perineal wound.

Operative Factors

Perforation. Perforation of the colon was found at surgery in five patients. This peritoneal soiling or contamination resulted in peritonitis and infection of the retrorectal pelvic space. Table IV shows great variation in the perineal healing time in these five patients. It would appear that perforation alone is not responsible for the failure to heal. Culture of the bowel contents found free in the peritoneal cavity at surgery shows a variety of colonic organisms (Table IV).

Pelvic Floor. The posterior parietal peritoneum of the pelvis was closed at surgery in thirty cases. In the two remaining cases the posterior peritoneum was not closed and healing of the perineum took place within three months.

Treatment of Perineum at Proctectomy. In two cases the proctocolectomy was performed in one stage from the abdominal approach. The anal and levator ani muscles were left intact during removal of the rectum. These two patients have represented two of the most difficult problems. The perineum remained unhealed after thirty-nine and forty-eight months. The drainage has been profuse and caused embarrassment and disability. Repeated incision and drainage of collected pus, curettage of the sinus tract and complete excision of the sinus tract and anal sphincter muscles have been necessary.

TABLE II
PERINEAL HEALING IN THIRTY-SIX MONTHS OR MORE

Patient	Age	No. of Months Before Healing*	Duration Before Surgery	ACTH	Cortisone
H. G.	34	72	10‡		
R. H.	31	60	1.5‡		
R. C.	17	48	3‡		
E. M.	21	54	2‡		75 mg.
T. L.	33	38†	14‡		
R. F.	23	47	8‡		6,700 mg.
G. B.	29	57	8‡	40 U.	8,165 mg.
J. T.	20	39	1‡	550 U.	525 mg.
F. T.	24	48	9§		

* The wounds were not healed in more than the number of months listed.
† This wound healed in thirty-eight months.
‡ Number of years.
§ Number of months.

In thirty patients the surgical dissection removed all of the rectum and anal muscles but as little adjacent tissue as possible since malignancy was not a consideration. The levator ani muscles remained largely intact. Small perineal incisions and soft rubber drains provided for free drainage. The drains were removed during the first ten postoperative days. The posterior parietal peritoneum was closed in twenty-eight of thirty patients. It appears that treatment of the perineum at surgery by resection of only the rectal wall and anal sphincters results in a wide variation in rate of healing. (Table III.) This factor alone cannot account for the persistent perineal sinus tract.

Healing of Staged Proctocolectomies. Of the thirty patients who had the posterior pelvic peritoneum closed at surgery, nine patients were operated on in two stages (colectomy followed by abdominoperineal resection of the

TABLE III
HEALING TIME OF PERINEUM IN THIRTY PATIENTS

No. of Patients	Healing Time (mo.)
4	0–6
12	7–24
5	25–36
9	Over 36

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TABLE IV
PATIENTS WITH PERFORATION OF COLON

Patient	Operation	Time to Heal	Culture of Peritoneal Fluid
E. M.	Proctocolectomy	Unhealed after 54 mo.	No aerobic or anaerobic growth
E. H.	Proctocolectomy	1 mo.	No aerobic or anaerobic growth
G. B.	Proctectomy	Unhealed after 57 mo.	Proteus, E. coli and Enterococcus
R. P.	Proctocolectomy	Unhealed after 21 mo.	Diphtheroids, E. coli
N. R.	Proctocolectomy	Healed after 9 months	Pseudomonas, Enterococcus and Proteus

rectum at a later date), and twenty-one patients had a single stage proctocolectomy. Healing occurred in less than six months in only one of nine patients who were operated on in two stages and four perineal wounds remained unhealed after thirty-six months. Among the twenty-one patients who were operated upon in a single procedure, four perineums healed in less than six months and five remained unhealed after thirty-six months. It is evident from this that staging of the proctocolectomies was not a significant factor in prolonging the healing of the perineum.

Postcolectomy Factors and Secondary Operations

Bacteriologic Study and Secondary Operations. Eleven patients had curettage or complete excision of the perineal sinus tract and cultures were made from eight of these wounds. No organisms were seen on culture in three cases and diphtheroids, Proteus, Escherichia coli, nonhemolytic Staphylococcus aureus and Sarcina grew in the remaining five cultures. Culture of specimens from these sinus tracts demonstrated a wide variety of bowel and skin bacteria.

Late Perineal Abscesses. Readmission of four patients was necessary for treatment of perineal abscesses which formed after the perineal skin had healed. The abscesses were superficial and there was no extension along the presacral space. The abscesses were treated by incision and drainage and healed within six months. Culture of the contents of these abscesses yielded Proteus in two cases, E. coli in one case and anaerobic Streptococcus in one case. These are organisms similar to those found in cultures of curettings from sinus tracts.

Curettage of the Sinus Tract. In twelve patients the sinus tract was treated by curettage of the excess granulation tissue. Surgery revealed that the sinus tract extended a surprising distance cephalad along the sacrum in most cases. In ten of the patients the sinus tract was over 10 cm. in length. A consistent stricture was found 1 to 3 cm. from the skin margin. This appeared to represent the site of insertion of the levator ani muscles into the rectal wall. The scar tissue was very dense and wide excision usually was necessary to identify the levator ani muscles. Curettage of these long sinus tracts did not promote rapid healing. In one case in which curettage was performed three times in two years there was a gradual decrease in length of the tract.

Complete Excision of Perineal Sinus Tract. In four cases the perineal sinus tract was treated by complete excision. The rationale for this treatment was to remove the circumferential scar tissue which was acting as a splint to keep the sinus tract open. This was successful in two cases in which the sinus tract was more superficial (5 cm. or less in depth). In the two remaining cases it was impossible to resect the sinus tract from the perineal approach because of the extreme depth of the tract. Excision of the fibrous wall of the distal 5 cm. of the sinus tract did not promote rapid healing in these two cases.

COMMENTS

It would appear from the review of these cases that a number of factors are unrelated to the formation and persistence of the sinus tract. These factors are age of the patient, use of ACTH and cortisone preoperatively, presence of perforation of the colon at surgery, specific bacteria, duration of disease before surgery and the number of surgical procedures performed to accomplish proctocolectomy.

What are the factors causing formation of a persistent perineal sinus tract in the patient with ulcerative colitis? We believe that the following factors may be of importance: (1) dead space in the pelvis, and (2) perineal obstruction to drainage of the pelvis.

A bilateral empty space remains after removal of the entire colon and becomes filled by loops of small bowel rather than colon. The small bowel becomes adherent in these lateral

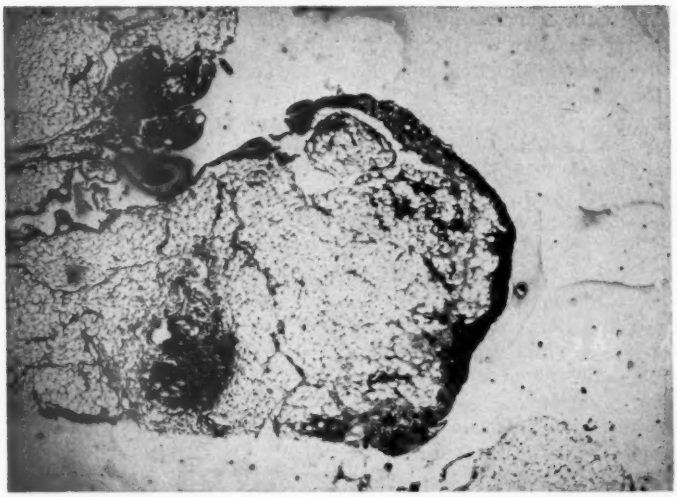

FIG. 1. Photomicrograph of pelvic parietal peritoneum taken before surgical dissection of the rectum to demonstrate the presence of scarring and chronic inflammation. Original magnification × 15.

spaces and thus fails to fill the pelvis. Consequently, there is no weight in the pelvis which will press upon the posterior parietal peritoneum and obliterate the presacral space beneath it. In addition to this lack of weight, the inflammatory process resulting from ulcerative colitis causes scarring and retraction of the colonic wall and the adjacent parietal peritoneum. (Figs. 1 and 2.) When the parietal peritoneum in the pelvis is approximated after resection of the rectum, it forms a diaphragm or tent which becomes fixed since the weight of the small bowel does not tend to stretch and depress it. This phenomenon contributes to the dead space in the pelvis.

Obstruction at the outlet of the perineal sinus tract appears to be a common factor in persistence of the sinus tract. Two of the more

FIG. 2. Photomicrograph of same section to show chronic inflammation. Original magnification × 250.

troublesome sinus tracts occurred in patients in whom the proctocolectomy was performed abdominally and the anal sphincter was not excised. Their postoperative course was characterized by intermittent drainage from the perineum and the anal sphincter was observed to function on physical examination with a resulting obstruction to drainage. Resection of the sphincter was necessary before healing would take place.

Obstruction due to scar tissue at the site of the attachment of the levator ani muscles to the rectum was a consistent finding during curettage of sinus tracts. This seems even more likely to be a significant factor when one realizes that the dissection performed during proctectomy for ulcerative colitis removes only the rectal wall while adjacent tissues are spared, as contrasted to the operation for cancer. Contraction of the levator ani muscles causes obstruction of the outlet which prevents proper drainage of the pelvis postoperatively.

Careful attention should be given to prevention of dead space beneath the parietal peritoneum of the pelvis. This can be done by obliterating the pelvic retroperitoneal space with sutures when the peritoneum is redundant. When the peritoneum is limited and closure creates a tent or diaphragm across the pelvis the posterior parietal peritoneum should not be closed. The small bowel could then drop into the pelvis and prevent dead space. In addition to this, the anal muscles should always be resected. This will prevent obstruction to free drainage at the outlet of the perineal sinus tract. Wider resection of the levator ani muscles (as in removal of the rectum for cancer) should also aid in promoting better drainage of the presacral pelvic space. Retaining this portion of the pelvic diaphragm serves no useful purpose.

The results of treatment of the patients with long sinus tracts over 5 cm. in depth were disappointing. Repeated curettage did not seem to promote rapid healing of the more cephalad part of the sinus tract. Total excision of the fibrous wall surrounding the more superficial sinus tracts (less than 5 cm. in depth) appeared to aid healing. Careful postoperative observation should be directed at prevention of scar tissue formation at the skin level. Treatment of the longer tracts should consist of removal of any obstruction near the orifice and intermittent removal of the redundant granulation tissue which forms deep within the sinus tract. This granulation tissue can be removed by surgical curettage or by chemical cautery. If the surgeon is persistent, healing will gradually occur over a period of months.

SUMMARY

1. Thirty-two cases of chronic ulcerative colitis treated by proctocoletomy are reviewed with special emphasis on the perineal wound. Each case was treated by total colectomy and removal of the rectum in one or more stages.

2. The perineal wound had not healed after more than three months in twenty-seven of these patients.

3. No relationship was found between the rate of healing of the perineal wound and age, use of ACTH and cortisone, presence of perforation of the colon at surgery, specific bacteria, duration of the disease before colectomy or the number of surgical procedures performed to accomplish proctocolectomy.

4. The etiology of the persistent perineal sinus tract is believed to be related to pelvic dead space and obstruction of the perineal outlet.

5. Prevention of the perineal sinus tract can be accomplished by allowing the posterior parietal peritoneum to remain open after resection of the rectum and by wider resection of the levator ani muscles.

6. The treatment of an established sinus tract is by proper drainage of the long tracts and by complete excision of the shorter sinus tracts.

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Operative Correction of Intestinal Stomal Difficulties

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WHEN the surgeon has completed the fashioning of the ileostomy or colostomy, the necessity for diligence has not ended. The patient may continue to need him not only in the postoperative weeks but also in the months and sometimes the years ahead. This belief was instrumental in the establishment of the Intestinal Rehabilitation Clinic at The Mount Sinai Hospital eight years ago.

We have found that difficulties in the management of intestinal stomas may be classified according to the following causative factors: (1) psychologic (such as inability to adjust to the stoma, anxiety), (2) mechanical (such as irrigation technic, use of apparatus, skin care), (3) physiologic (such as location of stoma in the intestinal tract, irritative enteritis), and (4) anatomic (such as stenosis, hernia, prolapse). According to our experience, less than 10 per cent of difficulties have anatomic causes subject to surgical relief.

Therefore, it should be emphasized that the solution of most of the problems is not to be sought in operation but in intensive study of each patient's complaints and the details of his treatment [*10,11*]. On the other hand, the results of operative correction can be spectacularly successful in the treatment of specific anatomic difficulties that are clearly the cause of the patient's symptoms.

COLOSTOMY

The type of colostomy which we have had to manage most frequently is the end colostomy after rectal resection, and the principal conditions requiring correction are stenosis and herniation.

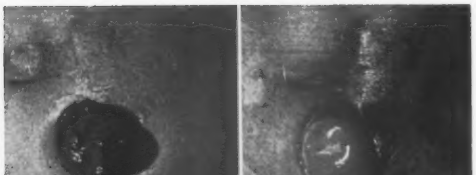
Stenosis. The narrowing almost always is located at the skin level. Fascial stricture in our experience has been an uncommon reason for stenosis.

The cause is often the original fashioning of the stoma. If the colonic limb is brought out through a stab wound, the incision may be too small and sometimes may be merely a slit. If the colon is exteriorized in the same incision as the exploration, the skin closure may be too tight around the stoma. We have noted no difference in the incidence of stenosis in the colostomy placed in the original wound and the stoma brought out through a separate stab incision.

A thick, constricting scar sometimes forms about the colostomy as a result of cellulitis or packings placed around the exteriorized limb to prevent retraction. Furthermore, the colonic limb which is brought out under tension with reliance on clamps or other mechanical means to hold it in place is apt to retract either suddenly or gradually and may eventually recede to a level beneath the skin.

If the stoma is placed in a stab wound when it is originally made, the excision of a wafer of skin is preferable to a linear incision. When the colostomy is in the same wound as the exploratory procedure, the skin around the stoma is best left loosely open rather than tightly closed. Surrounding packings are to be avoided if possible.

We have also found that exteriorization of a long limb which is later amputated by cautery is likely to result in edema and induration which may cause excessive fibrosis and stricture. This does not refer to the very effective procedure of secondary amputation and suture of the mucosa to the skin edges as originally described by Campbell and Schaerrer [*2*]. Actually, the direct suture of the open end of the bowel to the skin (either primarily or secondarily) is an efficient preventive of stenosis. When it is



A B

FIG. 1. A, colostomy without eversion ten days after resection of rectum. Note the edema and excessive granulation tissue which will be gradually covered by downgrowth of mucosa before healing is complete. B, colostomy with eversion technic ten days after resection of rectum. Note the virtually complete healing.

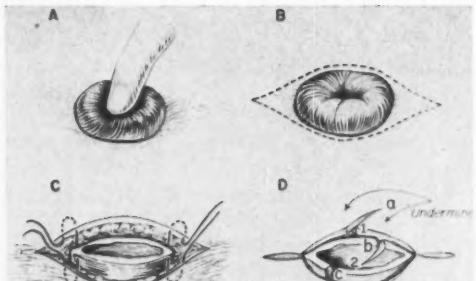


FIG. 2. Steps in the correction of colostomy stenosis by the Z-plasty technic.

feasible, we employ the method of Donald [*6*] and Lemmer and Mehnert [*8*] who sutured the stomal edges to the skin during the original operation. We prefer to turn back the full thickness of the wall (as in the technic of Brooke [*1*] for ileostomy) rather than to leave the opening flush with the skin. Thus, allowance is made for any later retraction of the colonic limb and for possible necrosis at the edges of the bowel.

Mucosa to skin suture has the advantage, in addition to preventing stenosis, of avoiding induration of the colon. It permits early functioning of the stoma, and promotes easier postoperative management. (Fig. 1.) To prevent retraction, the exteriorized limb must be brought up without tension so that it lies easily in place.

It is astonishing how often the patient can manage an extremely narrow opening with little or no difficulty. Digital dilitation has sometimes maintained the opening in a stenotic colostomy for years. When the patient has incomplete evacuation of hard stool, or repeated unscheduled emissions, and irrigations are prolonged and painful, operative revision is necessary.

Elliptical excision of the surrounding scar, mobilization of the subcutaneous part of the colon, circumcision of the scarred portion, and mucosa to skin suture of the bowel edges are often adequate. However, recurrences do occur after this procedure although they are uncommon. Revision by means of the Z-plasty technic has proved simple and effective without recurrence of stenosis in follow-up studies of up to seven years [*13*]. Twelve patients have had this type of correction. (Figs. 2 and 3.)

Herniation. Parastomal herniation is common. Over 20 per cent of patients who sought help for problems with the colostomy had small or large hernias. Colostomy herniation means enlargement of the abdominal wall opening through which the colonic limb protrudes. These are essentially incisional hernias.

Often the herniation is quite small and the stoma is on the summit of a small bulge. These minor hernias rarely require revision and produce no difficulties. They are not to be confused with the bulge in the subcutaneous space behind a stenotic stoma which is caused by ballooning of the subcutaneous portion of the colon by gas or impaction.

At times the hernia is quite large. Intestinal loops and omentum protrude into the paracolonic subcutaneous space, thus producing a massive bulge. The stoma may be of either normal or strictured caliber. We have noted paracolostomy herniations as frequently in stab wounds as in paramedian or midline incisions.

The symptomatology includes difficulty in introducing and evacuating enema fluid. The

bulge often has to be reduced by hand or by a makeshift corset during irrigation.

The cause may sometimes be loose closure of the abdominal wall about the exteriorized limb. Since we have rarely seen stenosis produced at the fascial level, we believe that the rectus sheath should be closed snugly around the bowel. We favor a fit close enough to grip the colonic wall but not tight enough to constrict the mesenteric vessels which would lead to edema or compromise of blood supply. If the end of the bowel is open in preparation for suturing the edges to the skin, the lumen should be snug about the finger at the peritoneal and fascial levels but wide open at the skin.

We also suture the appendices epiploicae to the fascial edges to help prevent the insinuation of loops of bowel or omentum beside the exteriorized colon. The mesenteric edge is sutured to the fascia in order to lessen the chance of either retraction or protrusion.

When a lateral stab wound is the site of the stoma, the mesentery should be sutured to the anterior and lateral parietal peritoneum when possible. This obliterates the space lateral to the colonic limb and serves to minimize herniation and protrusion as well as later entrapment of a small intestinal loop.

Repair is effected as in any incisional hernia. The sac is dissected, the contents are replaced, and the abdominal wall is closed by any standard means. Transposition of the colostomy to a separate stab wound permits more secure closure of the original incision. However, the colonic limb can be allowed to emerge, as before, from the same incision, using the precautions just enumerated to prevent herniation.

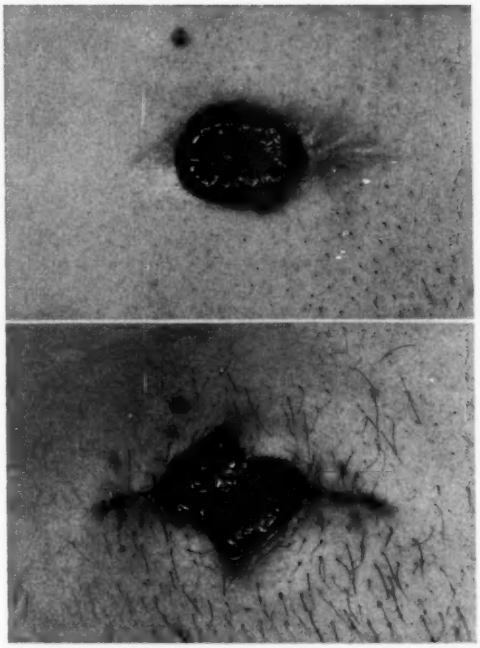


FIG. 3. Strictured colostomy before revision and one year after Z-plasty revision.

ILEOSTOMY

The most common complications of ileostomy requiring revision are stenosis, prolapse, and interfering peristomal contours.

Stenosis. The former frequency of ileostomy dysfunction as first summarized by Warren and McKittrick [*17*] has been markedly lessened by the technics of mucosal eversion (Brooke [*1*], Crile and Turnbull [*4*]). Moreover, the direct mucosa to skin suture has made later stenosis quite uncommon. However, it still occurs both in the ileostomies performed by older methods and in the newly designed stomas.

Cramps and profuse flow of large amounts of thin liquid are well known indications of stomal stenosis. Digital examination in these instances usually discloses a markedly strictured opening principally at the skin level. (Fig. 4.) The finger may be introduced relatively easily but withdrawal is followed by a gush of fluid fecal matter. A good diagnostic indication of stomal stenosis is the outflow of considerable fluid material on intubation of the stoma. If much retained material is obtained (with or without irrigation), a functional stenosis is probably present regardless of the size of the catheter which can be inserted.

However, a single episode of stomal obstruction (occasionally a bolus of food residue is the cause) or occurrences at long intervals are not necessarily indications for revision. Repeated obstructions or the presence of dilated or thick-walled ileum proximal to the stoma are evidence that revision is required. Madell and Golden [*14*] have shown that ileal dilation is abnormal and that the symptom-free ileostomy produces no change in the size of the ileum.

Excision of a wafer of skin, and mucosa to skin suture, are the essentials for prevention of stenosis. The skin opening must be large enough to accommodate the ileum, but the

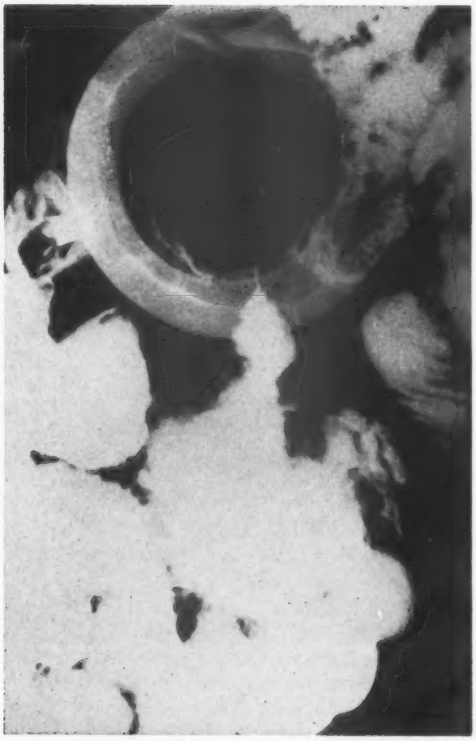


FIG. 4. Roentgenogram showing stenosis of the ileostomy. Note the narrowing of the lumen and the dilated, ulcerated proximal ileum.

mucosal edges may pull away and leave a deep trough and scar if it is too large. It is best to start with a circular opening slightly smaller than appears needed. By the time one is ready to make the eversion, the size of the skin opening often will be ideal. It can be enlarged at this time by excising an additional rim of skin if necessary.

The fascial opening must also be large enough to minimize later constriction, but a cruciate incision or a small circular excision will usually suffice. Sometimes the posterior sheath can be palpated as a firm edge when the peritoneum is opened, but there is a danger of promoting prolapse if this opening is made larger than is adequate to accommodate the ileum and its mesentery.

A finger should fit the lumen snugly at fascial and peritoneal levels when the stoma is examined but should find the ileostomy at the skin level widely open. Regular digital dilatation is advised by some physicians to maintain a widely patent stoma. We usually have found it unnecessary, but digital dilatation at each change of the appliance can have value if beginning tightness at the skin level is suspected.

Revision may be performed through the same wound or by transplanting the ileum to a new site. We have found the correction of stenosis at the same site effective and simple in the majority of instances (twenty patients). The base of the stoma is circumscribed by a circular skin incision which is deepened to the fascial level avoiding injury to the mesenteric vessels. The ileum is freed from its fascial adherence and the peritoneum is entered. The mesentery is freed as far as is necessary to permit delivery without tension of the dilated, thickened ileum.

At this point, the decision is made to proceed with either local refashioning of the stoma or resection of the dilated portion of ileum and transplantion of the stoma to a new site (usually to the opposite side of the abdomen). If the latter procedure is chosen, the incision will probably have to be enlarged or a new incision made in the midline to permit fixation of the mesentery at the new location.

If local repair is selected, the ileum is resected proximal to the stricture and the mesentery is fixed to the peritoneum as well as to the fascia. The full thickness of the bowel wall is everted and sutured to the skin edges. The skin opening must be adequate to fit the thickened wall doubled on itself. Thus the resulting ileostomy may be quite wide. This diameter shrinks considerably over the ensuing months. The fascial opening must be snug against the finger inserted into the lumen, lest shrinkage of the lumen cause a disproportion between the ileum and fascial opening which can lead to secondary prolapse. This has happened in one instance in which the precaution was not observed.

Although the diameter shrinks, the length of ileum exteriorized remains virtually unchanged. Thus, despite the recession of the width of the thickened ileum, the length of the ileostomy made at the time of revision will be permanent. Therefore, excessive length is to be avoided. We use a measurement of approximately 2 cm., the measurement preferred by most members of the ileostomy associations of New York and Boston [*10*]. However, there is no one correct length. In England, for example, the preferred measurement appears to be closer

to 2.5 cm. and 3.75 cm. Of course, a temporary, plastic pouch is cemented to the skin in the operating room at the conclusion of the procedure.

Retraction. A special form of stricture occurs when the ileostomy retracts to skin level or below. Ileum brought up under tension is prone to retraction, but we have treated a few ileostomies which have been placed without tension and yet which gradually sank enough to become strictured.

It is difficult to determine the cause of these infrequent occurrences. However, we have noted that a large ventral hernia of the left laparotomy wound accompanied the retraction in each of three cases. In one instance, a revision of the ileostomy alone was followed by a recurrence, whereas combined repair of the incisional hernia and transplantation of the ileostomy to a new site was followed by complete restoration without recurrence. Two others were similarly treated with no recurrence for up to five years. The pull of the ileum in its entrance into the large hernial sac apparently was responsible for the gradual recession of the stoma.

Prolapse. The reported incidence of this complication is as high as 20 per cent in one series [3] although it is considerably less in others. The incidence of 2 per cent reported at The Mount Sinai Hospital [12] has remained fairly constant.

PREVENTION

The following maneuvers have been advocated to prevent the sliding, intussuscepting, herniating protrusion of the ileum called prolapse: (1) fixation of the mesentery to the anterior parietal peritoneum; to the lateral parietal peritoneum, partitioning the upper and lower lumbar spaces; to the skin and mucosal edge of the stoma. (2) fixation of the ileal wall to the peritoneal and fascial edges of the abdominal opening [5]. (3) plication of the ileal limbs proximal to the stoma [7].

We have employed only the first group of procedures. Sometimes the position of the mesentery precluded the complete closure of the lumbar space by fixation of the mesenteric edge.

We believe that the only certain means of correcting prolapse is transposition of the stoma to a new site with as many of the preventive maneuvers as are practicable. All other methods, including the ingenious procedure

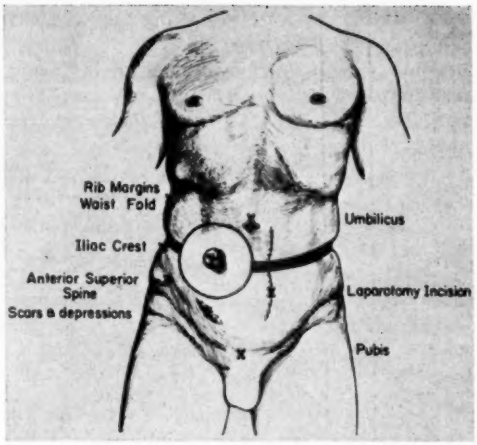


FIG. 5. The contours on the right side of the abdomen are more important than those on the left in determining the proper placement of the stoma.

described by Lichtenstein and Herzikoff [9], which attempted the correction by leaving the stoma at the same site, have proved fruitless in our hands.

Interfering Contours. When the proper wearing of an applicance has become impossible because of scarring, extensive granulations due to irritation, exceptional closeness to bony points, fistula, or any other local irregularity in the surface to which the applicance must adhere, revision becomes necessary.

A good method of minimizing interference is to determine the placement of the stoma well in advance of the operation. The diameter of the appliance disk is measured and mapped out on the abdomen, avoiding impingement on the anterior superior spine, the projected laparotomy incision, the umbilicus, natural wrinkles and valleys, and the costal margins. (Fig. 5.) A sham appliance with a belting is worn for a day or two to evaluate the suitability of the area chosen for ileostomy.

If all modifications of the appliance and mechanical tricks have failed to alleviate the difficulties caused by interfering contours, transplantation of the ileostomy to a new site is performed. The new area should be selected and tested before the revision is performed, lest one exchange old problems for new.

SUMMARY

The causes of stomal difficulties may be psychologic, mechanical, physiologic, or ana-

tomic. Operative correction was required in less than 10 per cent of cases. The principal conditions requiring operative correction of colostomy stomas were stenosis and herniation. The most common complications of ileostomy requiring revision were stenosis, prolapse, and interfering abdominal contours. A variety of surgical technics are available for prevention and correction of stomal difficulties caused by anatomic imperfections.

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Diverticulitis of the Right Colon

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DIVERTICULITIS of the right colon, although rare, occurs with sufficient frequency that every surgeon may be required to recognize and treat it. Since the first clinical description by Potier in 1912 [*24*], instances of this disorder have accumulated by the gradual accretion of small series of cases. Greaney and Snyder were able to compile a grand total of 273 published cases including fourteen of their own in 1957. Discussants of their paper alluded to twenty-one cases in their personal experience [*12*]. Without attempting an exhaustive survey of the literature, we have noted additional reports of forty-three cases by eleven authors [*2,3,9,10, 14,18,23,25,28,29,32*]. These, with the fourteen cases of the present series, make at least 371 reported surgically proved cases of diverticulitis of the right colon.

The incidence of diverticulitis of the right colon is low; however, an accurate figure is difficult to establish. Leichtling estimated that cecal involvement occurred in only 0.1 per cent of patients with colonic diverticulosis [*16*]. Anderson found only nine cases of cecal diverticulitis among 700 cases of surgically treated diverticulitis at the Mayo Clinic [*1*]; in 1954 that clinic had accumulated only thirteen cases of diverticulitis of the cecum, two of the ascending colon, and one of the hepatic flexure [*19*]. An interesting study by Case and Shea revealed 1.7 per cent and 5 per cent of cases affecting cecum and ascending colon, respectively, among 431 cases of colonic diverticulitis [*5*]. Greaney and Snyder found diverticulitis of the cecum in fourteen cases in a series of 6,781 emergency laparotomies [*12*]. At the Massachusetts General Hospital approximately 4,600 barium enemas are now performed annually in patients whose age averages about forty-five years. In roughly one-third of these instances some diverticulosis is noted. About one-third of this group show some evidence of diverticulitis. Yet, during the past twenty years we have performed only 269 resections for diverticulitis of the left colon, and only fourteen patients have had surgically proved diverticulitis of the right colon.

The clinical observations in this group of fourteen patients are interesting. The average age of these patients was forty-six years, contrasting with an average age of 60.1 years among patients who underwent resection for diverticulitis of the left colon. Duration of symptoms preoperatively averaged 2.4 days, and the most frequently encountered symptom was pain in the right lower quadrant (ten patients). In four patients the pain was initially periumbilical with a later shift to the right lower quadrant. Nausea and anorexia were noted in about half of the cases, but vomiting and diarrhea each appeared in only one instance.

Diagnostic signs were predominantly tenderness and spasm in the right lower quadrant which occurred in all cases. Rebound tenderness was elicited in eight instances, and a palpable mass was found five times in the series. Leukocytosis was moderate with the average leukocyte count being 14,000/cu. mm. The highest leukocyte count rose to 18,000/cu. mm.

Findings at laparotomy varied. In nine cases a perforated diverticulum with localized abscess was present, while inflammation was localized to the diverticulum in five cases. Associated left-sided diverticulosis was noted in three cases. A solitary diverticulum was present in eight of the group, and two of these contained fecaliths.

Operative procedures performed in this series included a one stage resection in six cases, and a two stage resection in one instance. Local excision of the diverticulum was performed on two occasions, and plication of the diverticulum and appendectomy was performed in one case.

Four patients underwent laparotomy only to establish the diagnosis, and in three of these an appendectomy was performed.

Results of treatment have been satisfactory. One patient who had an associated cholangioma of the left lobe of the liver died. Another patient has had subsequent recurrent attacks of left-sided diverticulitis.

The pathogenesis of diverticulitis of the right colon has been the subject of extensive study and debate. Greensfelder and Hiller [*13*] and Vaughn and Narsete [*31*] each enumerate eleven possible factors contributing to the development of diverticula of the cecum, but none of these seems applicable to many of the recorded cases. A concept of the problem requires consideration of the following factors:

1. The disease has been observed to occur at every age from three [*22*] to eighty-two years (oldest of the present series).

2. Diverticula of the right colon do not represent a misplaced vitellointestinal remnant (Meckel's diverticulum) [*22*].

3. Diverticula of the right colon may be of the "true" variety (being composed of mucous, muscular and serous layers), the "false" type (with mucous and serous layers only), or of indeterminate architecture secondary to destructive inflammatory changes. True diverticula are sometimes solitary, always few in number, and situated with greatest frequency in the cecum or proximal ascending colon [*15*]. They also occur in the vermiform appendix [*7*]. False diverticula in the right colon are usually associated with diffuse diverticulosis of the colon with maximum concentration of the lesions in the left colon [*26*].

4. Diverticulitis of the right colon occurs in younger patients than does diverticulitis of the left colon. The average for all reported cases is approximately forty years. Patients who have right colonic diverticulitis associated with extensive left colonic diverticulitis tend to be older. Of the present series, three patients with an average age of 70.7 years fall into that category.

5. Right colonic diverticula vary in size from a few millimeters (localized in the wall of the bowel with no visible external protuberance) to a condition which resembles duplication of the large bowel [*6,11,30,35*].

A plausible theory for the development of true diverticula of the right colon is ably presented by Evans [*8*]. Relying heavily upon the work of Lewis and Thyng [*17*], he concluded that enterogenous cysts and diverticula of the intestinal tract derive from aberrations in the vacuolization of the fetal entoderm. These originate as tiny clefts separate from the main lumen of the gut, and most of them eventually merge with the lumen and disappear. However, some of these clefts become partially surrounded by elements of the gut wall, retain a connection with the main lumen and persist as diverticula. The remainder lose all connection with the lumen of the gut and become enterogenous cysts (or duplications). This does not apply to Meckel's diverticulum which is a remnant of the vitellointestinal tract.

Factors promoting the development of false diverticula of the colon have been described in a previous paper [*26*]. Generally speaking, they seem to be closely correlated with the degenerative changes of advancing age.

Diagnostic criteria for diverticulitis of the right colon are nonspecific. The symptoms, physical signs and laboratory findings are those of an acute inflammatory process in the right mid- or lower abdomen. Approximately one-quarter of the patients give a history of previous similar attacks, and about an equal proportion have a palpable mass in the right lower quadrant [*27*]. Many reports indicate that nausea and vomiting occur less frequently than in acute appendicitis, and that the progression of the illness is somewhat slower than is the case with appendicitis. Most frequent misdiagnoses are acute appendicitis, appendiceal abscess, perforating carcinoma of the cecum, acute intestinal obstruction and acute cholecystitis [*12*]. Other conditions which should be considered in differential diagnosis include tuberculosis, actinomycosis, chronic ulcerative colitis, diffuse or segmental ileocolitis, intussusception, benign nonspecific ulcers of the cecum, amebiasis and perforation by a foreign body.

The use of roentgenograms as a diagnostic aid is limited by general reluctance to perform barium enemas in patients with acute abdominal inflammation. However, if the patient has had previous appendectomy, or if the condition is not too grave, a barium enema may be most helpful [*34*]. Since fecaliths occur in one-third to one-half of right colonic diverticula, a plain film of the abdomen is an advisable routine in this as in other acute abdominal illnesses [*20*].

The most frequent complication of right

colonic diverticulitis is perforation with localized abscess formation. Free perforation with general peritonitis, fistula formation, massive hemorrhage, and perinephric abscess occur rarely.

Treatment of diverticulitis of the right colon is usually surgical, although some cases have been observed to heal without operative intervention and others have been reported to heal following laparotomy or appendectomy without excision of the diverticulum [*1,3,4,10,16,21, 25,27,33*]. Nasogastric suction, parenteral fluid and electrolytes, and antibiotics should be used adjunctively if such a course is elected.

Interpretation of the operative findings may be extremely difficult. Occasionally intramural diverticulitis will present as a phlegmon of the bowel wall with no external protrusion [*6,30*]. One case of the current series was of this type. In other instances a large inflammatory mass may be indistinguishable from carcinoma. The location of some diverticula on the posterior wall of the cecum may require mobilization of this structure for accurate diagnosis. Palpation and inspection of the mouth of the diverticulum are unreliable guides since the openings may be occluded by edema secondary to acute inflammation. In many instances the correct diagnosis cannot be established until the specimen is sectioned by the pathologist.

The choice of operative procedure must depend upon the local conditions in each case. Generally speaking, conservatism should be the rule and the operation should be selected which is the least extensive means of ablating the disease. Thus, local excision of the diverticulum should be performed when possible (Fig. 1), but colonic resection should be selected

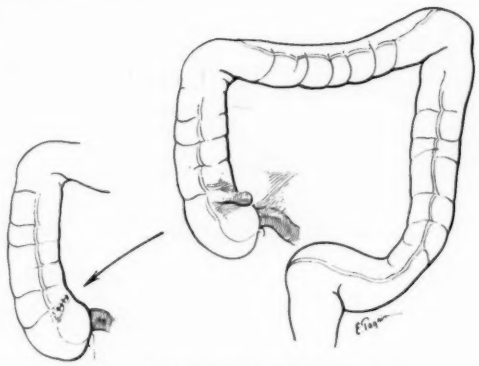

FIG. 1. Local excision of diverticulum.

if closure of the defect would be difficult or would jeopardize the patency of the bowel lumen (Figs. 2 and 3). If carcinoma cannot be excluded, a primary right colectomy is advisable. If an abscess is found, preliminary drainage may be required. When local excision of the diverticulum is performed, incidental appendectomy usually is performed, but this should be considered thoughtfully in each case depending upon the local disease process. Plication of an inflamed diverticulum is rarely possible, but this is an acceptable procedure if an uninflamed diverticulum is encountered as an incidental finding during laparotomy.

Postoperative complications should be few if the proper operative procedure has been used. In this series one patient developed thrombophlebitis with pulmonary emboli and another had dehiscence of the abdominal wound on the eighth postoperative day. During repair of this dehiscence a previously unrecognized cholangioma of the liver was noted and the left lobe

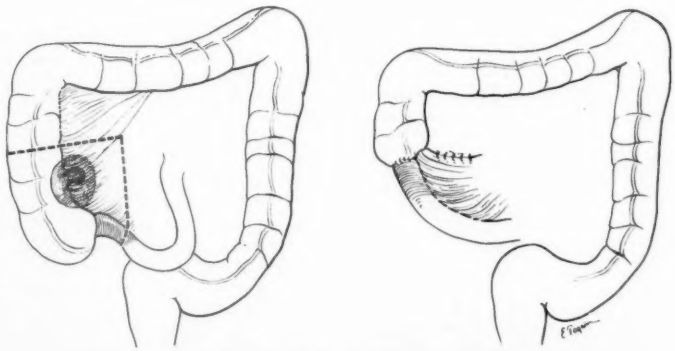

FIG. 2. Colonic resection for diverticulum.

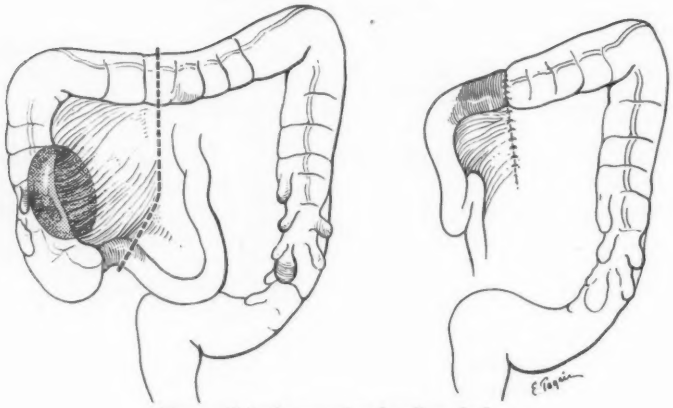

FIG. 3. Colonic resection for diverticulum.

of that organ was resected. The patient died five days later of pneumonia, Staphylococcal enterocolitis, and gastrointestinal hemorrhage.

The mortality rates reported for operative treatment of right colonic diverticulitis are correlated with the extent of the procedure performed. Local procedures have caused a mortality of about 5 per cent while the mortality in more extensive resections is approximately 10 per cent [*1,12,15,33*].

SUMMARY

Diverticulitis of the right colon is relatively rare, and it may occur at any age. However, since congential "true" diverticula are more common in the proximal colon, patients with this disease are on the average younger than those who have inflammation of acquired diverticula in the distal colon.

Accurate preoperative diagnosis is difficult since symptoms are often indistinguishable from acute appendicitis. At operation the disease may be mistaken for carcinoma of the cecum or ascending colon.

Treatment of the condition is usually surgical and is preferably limited to local excision of the diverticulum or to a resection just adequate to remove diseased tissues.

Summary of clinical features in fourteen previously unreported cases from the Massachusetts General Hospital is included.

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Diverticulitis of the Colon

A PRACTICAL EVALUATION OF PRIMARY ONE STAGE RESECTION

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THERE are many well documented reports of successful results following primary one stage resection of the colon for diverticulitis [1–12]. These papers have also convincingly demonstrated that the therapeutic evolution of this disease has been characterized by a progressive increase in the total number and relative percentage of primary one stage resections. Although this significantly reflects more aggressive "prophylactic" excision of quiescent diverticulitis, the increasing number of one stage resections also connotes a bolder approach by experienced surgeons to lesions that previously were treated by multiple operations. The important decrease in hospitalization time and operative morbidity attendant to a successful one stage resection needs little emphasis as the benefits are obvious.

Diverticulitis of the colon, however, possesses many facets ranging from asymptomatic disease found during a routine barium enema to lethal generalized spreading peritonitis resulting from perforation into the free peritoneal cavity. Furthermore, the resection of a well localized area of diverticulitis of the sigmoid colon, with uninvolved bowel available both proximally and distally for safe anastomosis, is an entirely different problem than that presented by severe intrinsic inflammation associated with marked pericolitis extending from the rectosigmoid junction to a point well up in the descending colon.

The experienced surgeon learns to respect the multiple clinical manifestations of diverticulitis. There is little place for a dogmatic approach to surgical management as it is imperative that each case must be individually evaluated. Otherwise, conformity to the progressive popularity of the primary one stage resection could easily be an invitation to disaster.

ONE STAGE PRIMARY RESECTION

Experiences with the surgical management of diverticulitis at The University of Michigan Hospital from 1934 to 1951 have been previously reported by Ransom [6]. In this series of fifty-three cases, fourteen primary one stage resections were performed. One death occurred due to postoperative hemorrhage. Two significant nonlethal complications attended these operations. In one case an anastomotic leak necessitated a diverting transverse colostomy subsequently followed by a second resection of the sigmoid colon and closure of the colostomy. In a second instance acute mechanical obstruction of the colon at the site of anastomosis necessitated an emergency cecostomy. As a group, however, follow-up results were good. In only one case was the result considered to be unsatisfactory.

From 1952 to 1956 160 cases of clinically significant diverticulitis of the colon have been treated at The University of Michigan Hospital. Of this number, fifty-two patients (33 per cent) have had one or more surgical procedures including twenty-four primary one stage resections of the total colon, left colon or sigmoid colon. (Table 1.) Conservative therapy was apparently successful for the remaining 67 per cent of this group. This percentage, however, could be fallacious as it does not include operative therapy performed at other hospitals subsequent to treatment at this clinic. Waugh and Walt have reported that 80 per cent of patients with colonic diverticulitis have been treated successfully by conservative measures [10]. In view of the fact that their series was considerably larger than the one reported herein,

TABLE I
THERAPY OF DIVERTICULITIS OF THE COLON
1952–1956

Operative Procedure	No. of Patients
Primary one stage resection	24*
Three stage procedures	18
Two stage procedures	4
Colostomy only	3†
Cecostomy only	1
Combined resection of rectum and sigmoid colon	1
Ileo-ascending colostomy	1
Total	52

* Four complimentary cecostomies are included.

† There was one postoperative death due to generalized peritonitis following sigmoid perforation and treated by diversion colostomy.

TABLE II
SIGNIFICANT COMPLICATIONS FOLLOWING PRIMARY ONE STAGE COLON RESECTION 1934–1956
(THIRTY-EIGHT PATIENTS)*

Complication	No. of Patients
Anastomotic leak (all requiring diversion colostomy)	4
Postoperative obstruction	2
Wound abscess	2
Injury to other abdominal viscera	1
Dehiscence of abdominal wound	1
Postoperative hemorrhage	1†
Total	11

* This includes the cases and complications previously reported by Ransom [6].

† The only death in this series was due to postoperative intra-abdominal hemorrhage (mortality, 2.7 per cent).

our statistics (67 per cent) on successful management by nonoperative means appear to be conservative and reasonably accurate.

Although the 1951 report [6] and the cases observed from 1952 through 1956 present the experiences obtained with only thirty-eight primary one stage resections, there is doubt that the lessons imposed could have had greater impact even though the number had been much larger. In the latter series the principle indication for operation in five cases was suspicion of malignancy. The lesion was sharply localized in the sigmoid colon in each instance, and uncomplicated resection was accomplished with relative ease. In the remaining fifteen successful operations, a safe anastomosis was permitted by the localization of the inflammatory process to the resected diseased segment of the colon. Therefore, relatively normal peritoneal surfaces were used for the anastomosis. Complementary cecostomy, however, was employed as a decompressive vent in four cases because of concern for the integrity of the anastomosis. The increased morbidity imposed by the cecostomy was of significance in one case. Recurrent periods of drainage from the cecostomy persisted for six months and, after healing, a small ventral hernia was repaired. It is conceivable that this form of decompression prevented a breakdown of the anastomosis in view of the subsequent clinical course.

There were eleven important complications (29 per cent) in the total series. (Table II.) One patient died during the postoperative period. The most serious complications were four anastomotic leaks which caused pelvic peritonitis and localized abscess. All required diverting transverse colostomy, subsequent secondary resection of the involved bowel and eventual closure of the colostomy. There was one common factor. It was extensive acute or subacute inflammatory disease involving the left colon and extending down into the rectosigmoid junction. In each instance pathologic examination of the resected bowel demonstrated an acute and extensive process.

There were no deaths in the second series (1952 through 1956). The over-all results have been good.

COMMENTS

Diverticulitis of the colon has not become a simpler problem. A more aggressive and confident approach by experienced surgeons has significantly increased the number of successful one stage primary resections and significantly contributed to operative therapy. To assume, however, that multiple stage operations will be completely abandoned does not seem reasonable. There will always be a place for them in certain instances because of severe and advanced inflammatory involvement of the bowel and peritoneal surfaces.

All of the surgical components of colonic diverticulitis have been reasonably represented in this series. For practical purposes they may be divided into three groups.

1. Sharply localized lesions which are usually in the mid-sigmoid and often difficult to differentiate from malignancy. These inflammatory masses are easily resectable and present no singular problems in the establishment of a safe anastomosis.

2. The second group includes patients with diffuse inflammatory infiltration and pericolitis with varying degrees of quantitative involvement of the left colon. The amount of "normal" sigmoid colon distal to the inflammation is an important determinant factor as to the relative safety of primary resection. Attempts at primary resection when there was inflammatory involvement of a large portion of the left colon resulted in four serious anastomotic leaks in this series. It is of interest to observe that microscopic examination of the resected bowel confirmed the widespread acute and subacute process that was dangerously close to the ends of the specimens.

3. The last group had multiple stage operations, which were usually preceded by diverting colostomy. Secondary surgery was necessitated because of emergent complications, extensive inflammatory involvement, advanced debilitation, or colonic resection attended by simultaneous proximal colostomy to protect anastomoses that did not appear maximally safe.

Two considerations are imposed by symptomatic diverticulitis devoid of emergent surgical considerations of acute obstruction, perforation into the free peritoneal cavity, perforation with extensive pelvic abscess and exsanguinating hemorrhage. They are when determination of conservative therapy should be abandoned and operation recommended, and selection of conditions in which a primary one stage resection of the diseased segment of colon may be accomplished safely.

If 80 per cent of patients with symptomatic diverticulitis can be treated conservatively [*10*] (67 per cent in this series), the decision for operative intervention frequently could be difficult. Certain indications, however, appear relatively clear and valid:

1. Inability to differentiate inflammatory narrowing of the colon from malignancy. About 25 per cent of these cases present this problem.

2. Repeated attacks of diverticulitis necessitating hospitalization is another consideration. This is particularly true if the time interval between attacks rapidly becomes shorter.

3. Surgery must be considered when resolution of an acute process does not occur with adequate conservative treatment. Although timing may vary considerably, the persistence of a mass, subacute obstruction, pain, and chills and fever for more than seven days would suggest that surgical intervention will become necessary.

4. Progressive symptoms of urinary tract involvement are another indication. Demonstration of a sigmoid vesical fistula is unequivocal indication for operation.

5. Operative intervention is indicated for other internal or external fistulas.

6. Although melena is uncommon, left colectomy has been necessary for massive exsanguinating hemorrhage. For the most part, however, rectal bleeding is not a primary reason for operative intervention.

It would appear that the number of symptomatic cases of diverticulitis treated conservatively remain considerably greater than those requiring elective or emergency surgery. Prophylactic resection of all identifiable diverticulitis would be the only method of preventing complications that necessitate two and three stage operations. It would not seem unreasonable, however, to assume that the eventual morbidity, mortality, and hospitalization costs of such a blanket approach would far outstrip that attendant to complications resulting from a more conservative attitude in which each case is individualized and treated on its own merits.

The decision for primary one stage resection can be most difficult at the time of operative exploration. The following criteria must be reasonably fulfilled to provide maximum potential for success and to keep complications at a minimum.

1. The colon should be properly prepared. This includes adequate mechanical cleansing of retained fecal material and retained barium as well as the use of intestinal antibiotics.

2. The patient's general condition should be adequate to tolerate an extensive mobilization of the colon. For the elderly patient or poor risk patient a careful estimate of the potential margin of operative safety should be made in case of an anastomotic leak.

3. The anastomosis should be made with colon that is relatively free from edema, thickening and pericolic fat. Internal or external fistulas do not necessarily contraindicate primary resection.

4. No tension should be present on the

anastomosis. Adequate mobilization of the colon is an absolute necessity if sufficient length for anastomosis is to be obtained. This is particularly applicable to the distal stump of the sigmoid colon as the better the mobilization the safer the anastomosis should be. Obtaining an adequate length of proximal colon usually is not difficult since the left half of the transverse colon, in most instances, can be easily brought down to the rectosigmoid if inflammatory foreshortening of the transverse colon or its mesentery has not occurred.

5. Meticulous care in the toilet of the wound is important. This should include provision for minimal fecal contamination of the wound edges, copious irrigation of the wound during closure, absolute hemostasis and minimal burying of suture material in the subcutaneous fat.

Experience has demonstrated that neither roentgenograms of the colon nor clinical symptoms are particularly effective in delineating the extent and severity of the inflammatory process. Maximum assessment of the condition and the decision for primary resection can be made only by exploratory laparotomy. The surgeon experienced in colon surgery quite obviously will have somewhat greater latitude in justifying a decision for one stage resection. Regardless of the degree of experience, however, reasonable conservatism in certain questionable cases expressed by utilization of a simultaneous temporary diverting colostomy or cecostomy remains an important therapeutic adjunct in the operative management of diverticulitis of the colon.

SUMMARY

1. Experiences with thirty-eight patients who had primary one stage resection of the colon for diverticulitis are presented.

2. The safety and practicality of the operation is reaffirmed but it certainly cannot be used in all cases of colonic diverticulitis.

3. Indications for operation and certain essential criteria for safe resection are discussed. A significant decrease in the admittedly high number of complications should be achieved by limiting primary resection to cases in which there is a good chance for success. Minute attention must be given to operative detail and care of the wound.

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Acute Sigmoid Volvulus

CONCEPTS IN SURGICAL TREATMENT

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VOLVULUS of the sigmoid colon appears to be increasing in frequency as a cause of obstruction of the large bowel. Despite the general agreement that this is a recurrent disease and that resection should be the ultimate goal of therapy, considerable controversy exists concerning management of the acute episode. We have adapted a nonoperative method of decompression utilizing the sigmoidoscope followed by insertion of a long rectal tube following the work of Bruusgaard [1]. Some surgeons have hesitated to accept this method chiefly because of the fear of producing perforation or the possibility of the presence of unrecognized gangrene. Others have advocated nonoperative decompression only in patients whose general condition prohibits laparotomy. Perhaps the single most important factor responsible for the controversy in this country has been the general lack of experience with this method in a series sufficiently large to warrant valid conclusions.

MATERIAL

A study of forty consecutive patients with sigmoid volvulus who were treated at The Edward J. Meyer Memorial Hospital in Buffalo, New York from 1945 through 1959 is discussed herein. The increased incidence of this disease was apparent in the last five years when over half of the cases were treated. There were seventy-one admissions for sigmoid volvulus in this group of forty patients in whom a total of 116 episodes of volvulus were treated. Twenty-seven men and thirteen women comprised the study, a 2:1 sex ratio. The youngest patient was eighteen months of age, and the oldest was ninety-four years. (Fig. 1.) Eighty-eight per cent of the patients were fifty years of age or older. Most of these patients were admitted to the house service, and a high percentage of them also had serious cardiovascular

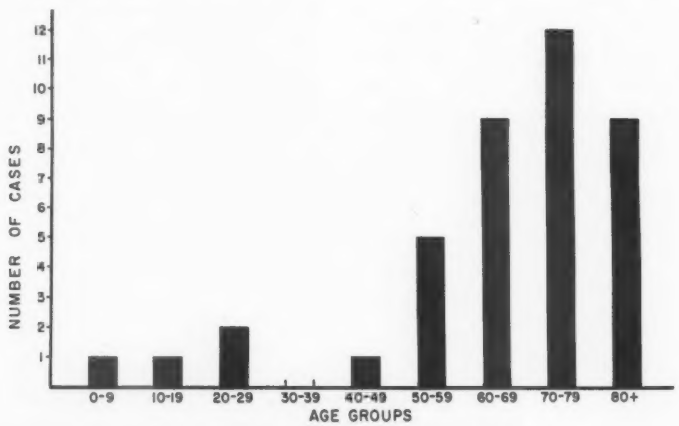


FIG. 1. Age incidence and sigmoid volvulus.

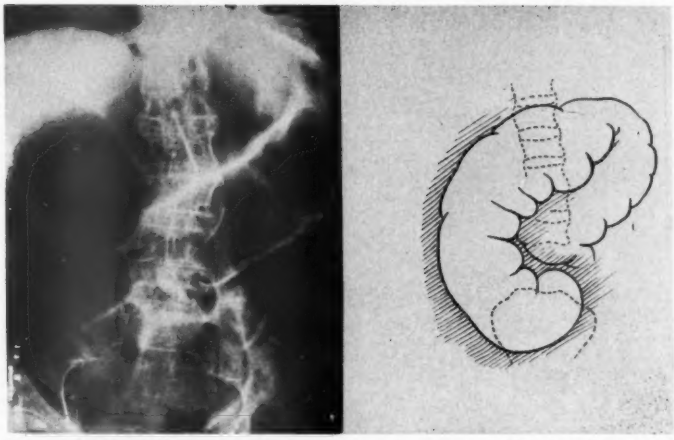


FIG. 2. Marked distention of a colonic loop is present exhibiting the typical "bent inner tube" appearance.

and pulmonary disease attendant to their advanced age. It was also significant that four of the five patients below fifty years of age had severe neurologic diseases including post-encephalitic Parkinsonism, cerebral palsy, and cretinism.

DIAGNOSIS

The clinical picture was variable, but the majority of patients complained of abdominal pain, exhibited marked abdominal tympanitis and gave a history of chronic constipation which required the frequent use of laxatives and enemata. Vomiting was not a prominent feature. In the younger patients, however, the disease was characterized by a shorter, more fulminating course suggesting an acute abdominal catastrophe.

The diagnosis of sigmoid volvulus is usually readily apparent in a supine scout film of the abdomen, which typically reveals a greatly distended loop of colon which arises from the pelvis and fills most of the abdominal cavity. (Fig. 2.) Dilation of the proximal colon occurs

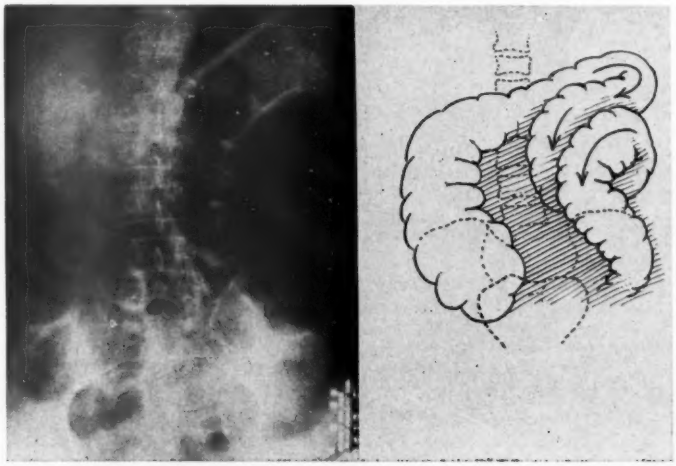
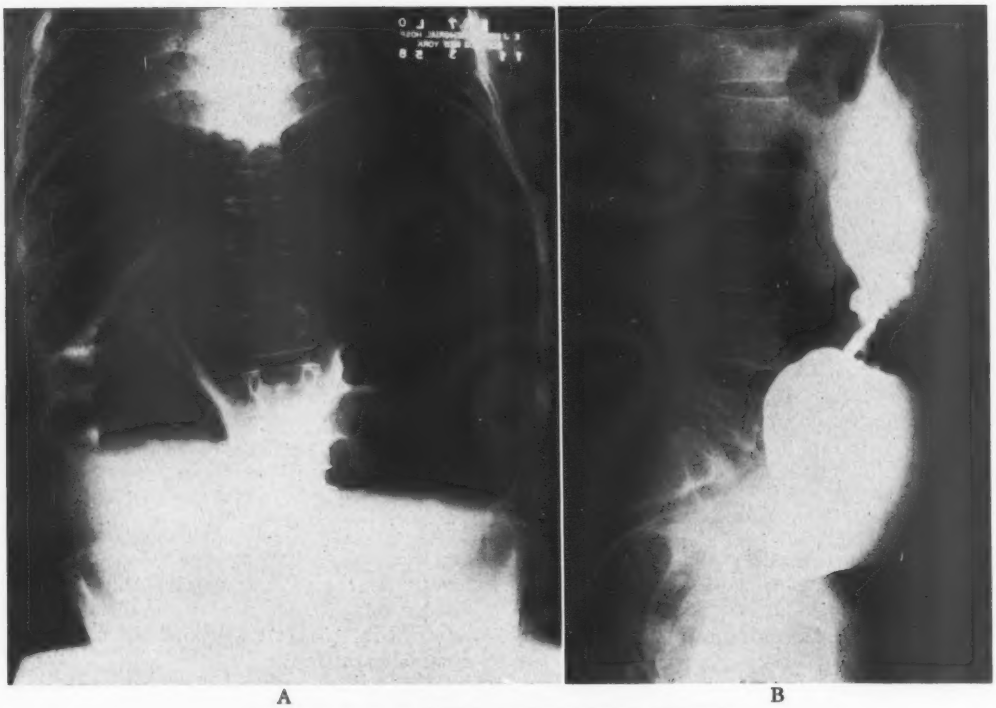


FIG. 3. Advanced obstruction is present with multiple dilated loops of colon and dilated cecum. Diagnosis may be obscure in such a case. Barium enema should be performed if any doubt exists as to the true nature of the obstruction.



A B

C

FIG. 4. This twenty-six year old patient had cretinism with sigmoid volvulus. A, scout film shows huge loop of colon with fluid levels. B, barium enema reveals twisting of distal sigmoid limb and typical "bird-beak" appearance. C, another view of B.

with progression of the obstruction. This results in the roentgenographic appearance of multiple loops of colon (Fig. 3) and of distal small bowel if the ileocecal valve is incompetent. Under these circumstances the twisted, closed sigmoid loop may be obscured and an erroneous diagnosis may lead the surgeon to perform an ineffective cecostomy or proximal colostomy. Retrograde barium study may reveal a typical twisting or the usually described "bird's beak" deformity in the lower sigmoid with an obstruction to the flow of barium. (Fig. 4.)

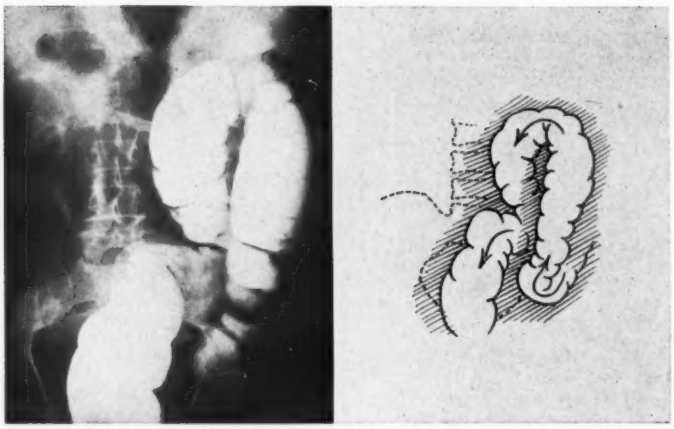


FIG. 5. Atonic, elongated sigmoid loop in a seventy-five year old patient, one week following decompression of acute sigmoid volvulus by sigmoidoscopy and rectal tube. The patient refused elective resection. Volvulus recurred two months later and was again successfully decompressed.

Barium enema performed after detorsion of the sigmoid volvulus will invariably reveal a markedly redundant, dilated, and atonic sigmoid colon which evacuates poorly. (Fig. 5.) A considerable quantity of barium may be needed to outline the entire colon.

EMERGENCY TREATMENT

Table 1 outlines the primary emergency treatment given forty patients with seventy-one admissions for acute sigmoid volvulus. Many of the episodes were treated during the early part of the study when a specific program of management had not been established. This accounts for some of the surgical procedures listed. In the last eight years of the study primary resection for viable bowel has not been performed. Cecostomy and sigmoidostomy have been abandoned as inadequate and dangerous procedures.

The use of the sigmoidoscope followed by insertion of a rectal tube for treatment of the acute volvulus was a very effective procedure with practically no mortality or complications. Laparotomy and detorsion of the twisted loop was performed in ten episodes with three postoperative deaths.

Primary obstructive resection was performed in five patients with a nonviable bowel with three deaths, and in three patients with a viable bowel resulting in one death. The total mortality was 50 per cent by this method. Largely due to this experience, we have now abandoned primary resection except in the presence of a strangulated volvulus.

RECURRENCE RATE

An analysis of the 116 total episodes of sigmoid volvulus treated in forty patients in this study is shown in Table 11. Sixty per cent of the patients had two or more episodes of volvulus while nine (22 per cent) had five or more episodes. This represents a mean of 2.9 episodes of volvulus per patient and clearly elucidates the highly recurrent nature of this disease. The following case illustrates the problem of recurrence.

A forty-three year old patient was admitted to The E. J. Meyer Memorial Hospital in 1953 with an

TABLE 1
PRIMARY EMERGENCY TREATMENT (71 ADMISSIONS)

Treatment	No. of Admissions	Deaths	Mortality (%)
Sigmoidoscopy and rectal tube	44	1	2.3
Operative reduction	10	3	30
Primary resection	8	4	50
Cecostomy	4	2	50
Enema	3	0	0
Sigmoidostomy	2	1	50
Totals	71	11	15.5

TABLE II
ANALYSIS OF EPISODES OF SIGMOID VOLVULUS
(40 PATIENTS)

Episodes of Sigmoid Volvulus	No. of Patients
1	16
2–4	15
5–7	7
8–10	2
Totals	
116	40

acute sigmoid volvulus. Twenty years previously severe progressive paralysis agitans had developed following an episode of encephalitis. For the five years prior to admission, he had been confined to a nursing home. Laparotomy and reduction of the volvulus were performed, and the patient did well postoperatively except that he required daily laxatives and an occasional enema for chronic constipation. He was admitted again on November 13, 1958 with a history of obstipation, severe crampy abdominal pain, and progressive abdominal distention for five days. His abdomen was tense and loops of bowel could be outlined on the abdominal wall. Scout film of the abdomen revealed the typical picture of sigmoid volvulus. (Fig. 6A.) At sigmoidoscopy a gush of air and liquid feces occurred at a level 20 cm. from the anus, and his abdomen deflated immediately. A rectal tube was inserted (Fig. 6B), and a program of daily irrigations and catharsis was instituted to prepare his bowel for surgery. On November 28, 1958 he sustained a cardiac arrest during induction of anesthesia for a proposed colon resection and was successfully resuscitated by cardiac massage. He was subsequently discharged without resection.

He was readmitted on July 15, 1959 with another episode of volvulus which could not be reduced by the sigmoidoscope. Laparotomy and detorsion were performed. Ten days postoperatively, the volvulus again recurred and was easily reduced with sigmoidoscopy and a rectal tube. On August 4, 1959 laparotomy was performed under continuous spinal anesthesia. The entire colon was atonic, thickened, and edematous. The sigmoid was extremely redundant (15 cm. in diameter) and had a long mesentery. A subtotal colectomy with anastomosis of ileum to rectum was performed. His postoperative course was uneventful until the fifth day when he developed a bilateral pneumonia and died.

NONOPERATIVE DECOMPRESSION

Table III shows our total experience with nonoperative management of acute episodes of volvulus. In ninety-eight episodes an attempt was made to achieve reduction of the volvulus through the sigmoidoscope. Successful decompression was achieved in eighty-two of these attempts, a rate of 84 per cent with a mortality rate of 1.2 per cent. Perforation of the bowel

A B

FIG. 6. This forty-nine year old patient had severe postencephalitic Parkinsonism. A, typical acute sigmoid volvulus (bent inner tube appearance) on scout film. B, the same patient a few hours later after insertion of long rectal tube (outlined with barium for purposes of illustration) through the sigmoidoscope. A gush of air and liquid feces was encountered at a level of 18 cm. Scout film reveals excellent decompression of the sigmoid loop.

TABLE III
RESULTS OF NONOPERATIVE MANAGEMENT

Sigmoidoscopy and Rectal Tube	No. of Episodes	Deaths	Mortality (%)
Successful	82	1	1.2
Unsuccessful	16	8	50
Nonviable (5)			
Viable (11)			
Total attempted	98	9	9.2

TABLE IV
DEFINITIVE TREATMENT (33 PATIENTS)

Treatment	No. of Patients	Deaths	Mortality (%)
Primary Resection			
Nonviable	5	3	
Viable	3	1	50
Elective Resection			
Sigmoid	12	1	
Subtotal colectomy	3	1	13.3
Survived acute episode			
No resection	10		

due to instrumentation did not occur in any patient. One death occurred shortly after sigmoidoscopy as a result of an acute myocardial infarction. Autopsy revealed that the volvulus was successfully reduced.

Nonviable bowel was present in five of the sixteen episodes classified as unsuccessful. These included three instances in which dark blood and frank mucosal ulceration were seen through the sigmoidoscope at which time the procedure was immediately abandoned. In the other two patients, the diagnosis of strangulation was not immediately apparent. However, successful decompression could not be accomplished and laparotomy was performed immediately. In the remaining eleven unsuccessful attempts at nonoperative decompression, a viable bowel with a twist greater than 720 degrees was noted at subsequent laparotomy. In nine of these latter cases operative detorsion was used; in two cases obstructive resection was performed. The mortality was 50 per cent among patients who required subsequent procedures after attempts at nonoperative reduction failed. Nevertheless, we do not believe that an unsuccessful attempt at nonoperative reduction materially affected the outcome of the subsequent procedure inasmuch as no complications or delays in treatment were produced. It also should be noted that some of these episodes which were successfully reduced through the sigmoidoscope occurred in patients in whom detorsion had been performed at a previous laparotomy.

The majority of these patients was treated by surgical residents. Many of these physicians had never attempted decompression of a volvulus through the sigmoidoscope. Figure 6 illustrates the excellent decompression obtained in a patient who was critically ill from respiratory difficulty as a result of a markedly distended sigmoid loop. Relief following sigmoidoscopy was almost instantaneous in this case.

DEFINITIVE TREATMENT

It became apparent with the increasing survival rate resulting from nonoperative decompression of the acute obstruction that the problem of eventual definitive treatment needed careful analysis. This was particularly true later in the series when many elderly and debilitated patients became candidates for ultimate excision of the colon. Table IV depicts the results of the definitive treatment in the thirty-three patients who either survived the acute episode or had a resection at the initial episode. A total of twenty-three patients had a definitive resection.

Primary obstructive resection was performed as emergency treatment in eight patients. Four of these patients died, a mortality of 50 per cent. Three of these deaths occurred in patients with strangulated volvulus which points out the extremely poor prognosis in the presence of gangrene.

Elective sigmoid resection was performed in twelve patients, after successful management of the acute volvulus, with only one death. In three patients a subtotal colectomy with ileoproctostomy was performed because of the marked redundancy and atonicity of the entire colon. Death resulted in one patient from postoperative pneumonia. The mortality from elective resection was 13.3 per cent.

Among the ten patients who survived the acute episode and did not have either primary or elective resection, five have had one or more successfully treated recurrences, three have died

of associated disease without recurrence within one year, and two have been lost to follow up. In most of these instances the patient either refused definitive resection or the surgeon believed that the patient was too debilitated to withstand elective surgery.

COMMENTS

Although volvulus of the colon is alleged to be relatively uncommon in the United States, statistical studies in the eastern European countries have demonstrated that volvulus of the intestinal tract accounts for 30 to 50 per cent of all intestinal obstructions. The reasons for this are not readily apparent but it has been suggested that diets high in vegetables and residue may play an important role.

The largest experience with the treatment of sigmoid volvulus was reported by Bruusgaard of Norway in 1947 [1]. In a series of ninety-one patients who had 168 hospital admissions for volvulus, nonoperative decompression was successful in 123 of 136 attempts with only four deaths. Therefore, 90 per cent of the treatments were successful and the mortality was 2.9 per cent when conservative treatment was used. Our figures, showing an 84 per cent treatment success rate and a 1.2 per cent mortality rate with this method, are similar. These studies appear to be adequate refutation of the thesis that nonoperative decompression is dangerous. Others have reported similar success with this method in a smaller series of cases. Hamlin [4] described ten successful detorsions in eleven attempts by sigmoidoscopy and rectal tube or enema with no mortality. Isaacson and Greer [6] had seven sucessful results in seven attempts with a single mortality from an unrelated cause.

Various authors have established that the mortality in acute sigmoid volvulus treated by operative methods is approximately 20 to 50 per cent. Hinshaw and Carter [5] reported a mortality of 22 per cent resulting from laparotomy and detorsion in eighteen patients, and a 41 per cent mortality from obstructive resection in twenty-four patients. Their small experience with nonoperative decompression revealed four attempts with complete failure. Despite the rather high mortality by operative methods, they state that "nonoperative decompression is dangerous and should be reserved for the patient whose general condition prohibits laparotomy."

Griffin and his associates [3] reported a mortality of 46 per cent in thirteen cases treated by primary exteriorization resection. Only three of these cases had a nonviable colon. They conclude that: "Volvulus of the sigmoid tends to recur and therefore simple detorsion is not the treatment of choice. Exteriorization and second stage resection give the best results." Our results show a mortality of 30 per cent from operative detorsion and 50 per cent from primary resection and concur with their figures but not with their conclusions.

The occurrence of sigmoid volvulus in patients with neurologic defects or mental diseases appears to be a significant one especially in younger patients. Dean and Murry [2] cite an incidence of neuropsychiatric disease in fifteen of twenty-one patients. They have suggested that the findings in all such cases resemble an "acquired megacolon" which, by virture of its weight and tendency to elongate with the passage of time, becomes a threat to the patient. In three young patients in our series the entire colon was noted to be atonic, hypertrophied and redundant at laparotomy. Elective resection was extended to include subtotal colectomy and ileoproctostomy, a procedure which was easily performed because of the redundancy of the colon. One death occurred from postoperative pneumonia, but the two patients who survived this procedure have had no further episodes of constipation or difficulty in evacuation.

The fact that volvulus can recur once a patient has had an episode is not surprising in view of the marked atonicity and dilatation of the colon which is usually present. The fecal content of this elongated loop, by virtue of its weight, can cause it to fall into the pelvis, twist on itself and becoming fixed in position. This is aggravated by the increasing distension as obstruction progresses.

The technic of nonoperative decompression that we have adopted is essentially as described by Bruusgaard. If uncertainty exists as to the diagnosis after a preliminary examination and scout film, a careful barium enema should be performed in order to ascertain the level and cause of the obstruction. Proctoscopic examination is best performed in the knee-chest position or preferably on a proctoscopic table leaving the abdomen unsupported, a technic which allows the enlarged sigmoid loop to hang free from the pelvis. A well lubricated sigmoidoscope is then passed into the rectal ampulla (which is usually

empty) and carefully advanced under direct vision to the point of obstruction. In most cases this lies in the region of the rectosigmoid junction or slightly higher. Careful inspection in the region of the obstruction will allow the examiner to determine whether mucosal ulceration, inflammation or blood are present. The latter sign usually denotes compromise of the wall of the bowel. If any of these signs are noted or the patient complains of pain, the procedure is abandoned immediately. As the site of obstruction is approached, a prompt and forceful evacuation of gas and liquid feces occurs. In other instances gentle manipulation of the sigmoidoscope allows it to slip easily past the obstruction. A large (40 to 60 cm. in length) rectal tube can then be inserted through the sigmoidoscope and secured to the buttocks with adhesive tape. Decompression can be confirmed clinically and by a repeat scout film. We have advocated leaving the rectal tube in place for a few days until complete evacuation of fecal content can be assured, in order to prevent early recurrence. The danger of perforation due to the manipulation is minimized by the thickened and hypertrophied wall of the colon which on occasion has exceeded 1.5 cm. in thickness.

Because of the high recurrence rate in patients treated by this method, it is imperative that definitive resection be performed as soon as adequate preparation of the colon and the general condition of the patient warrant. Our experience with subsequent elective resection in fifteen patients (mortality of 13.3 per cent) shows that this is an acceptable procedure and should be considered for all patients who can withstand further elective surgery.

SUMMARY

1. A series of forty patients with seventy-one admissions for acute sigmoid volvulus was described. A total of 116 episodes were treated.

2. Nonoperative decompression with a sigmoidoscope and a rectal tube was successful in eighty-two episodes of acute sigmoid volvulus in ninety-eight attempts with only one death which was apparently unrelated to the procedure. In no instance did failure of this treatment appear to complicate the subsequent operative treatment performed. Mortality from operative detorsion was 30 per cent; in primary resection, it was 50 per cent.

3. An analysis of the recurrence rate reveals that 60 per cent of patients had two or more episodes of acute sigmoid volvulus which required treatment. This suggests that definitive resection of the redundant colon should be the ultimate goal of therapy.

4. A rational treatment based on nonoperative decompression of the acute, nonstrangulated episode of sigmoid volvulus is discussed.

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Transabdominal Operative Visualization of the Mucosal Surface of the Large Bowel

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SURGEONS have been somewhat hampered at operation in their attempt to locate multiple small polyps in the colon. For the most part, this is due to the difficulty in visualizing the entire mucosal surface of the large bowel. The information provided by a preoperative barium enema is usually limited to the detection of large polyps. According to Deddish and Hertz [2], the limitation of roentgenographic diagnostic technics in the demonstration of polyps less than 1 cm. in diameter has been recognized.

At present the method most widely employed in attempting to discover these small polyps at the time of operation is by utilizing a conventional sterilized proctosigmoidoscope to inspect the lumen of the intestines. The instrument is inserted through an opening in the wall of the previously sterilized bowel and the mucosal surface is explored.

This procedure leaves much to be desired because of the following drawbacks: (1) the operating room must be dark in order for the small scope light to provide adequate illumination of the localized field; (2) electric wires from a rheostat are needed to power the light source; (3) the lumen must be distended by inflating air by means of a hand bulb; (4) if liquid material is encountered, it will run up into the hollow scope and obscure vision until removed by means of a suction apparatus; and (5) if some solid fecal material is encountered, its removal can be accomplished only by the use of long, cotton-tipped swabs or by the reintroduction of the obturator.

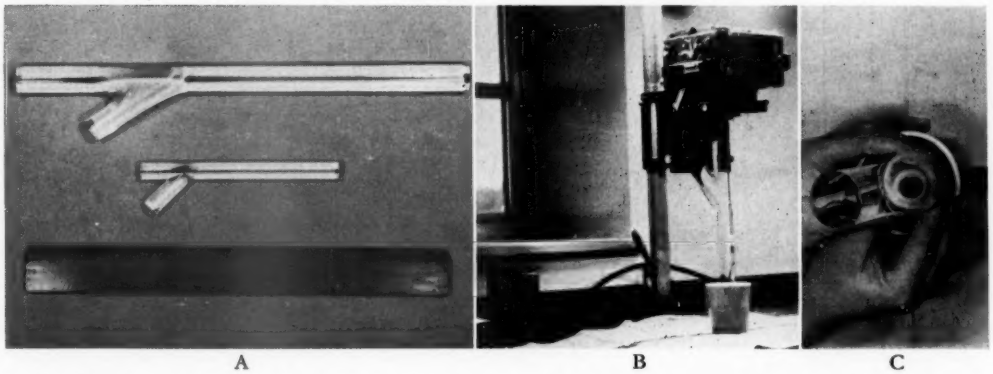
In 1956, Gants, Raymond and Pope [3] attempted to solve this problem. They wanted to be assured of greater accuracy than simple sigmoidoscopic examination through a colotomy opening would provide and they proceeded to do what they described as an extended incisional colotomy. This permitted direct examination of the surface of the lumen of the entire colon. The procedure was performed first in the experimental animal and later employed in patients. The monkey was used in this study.

Their procedure consisted of making an incision throughout the length of one of the taenia coli. This incision extended from the cecum up to the hepatic flexure, across the transverse colon, around the splenic flexure and down the left colon into the sigmoid. By their method, every bit of mucosa was then exposed for direct visualization.

The associated shock and the time required to open and close the entire taenia makes this a procedure of considerable magnitude. The indications which would justify such an operation seem to be quite rare. This lack of enthusiasm is shared by Deddish and Fairweather [1], and by Higgins [5].

Since the problem of detection of minute polyps appeared to be of such significance that Gants *et al.* went to the extent of performing an operation of the magnitude described herein, it would appear that we would be providing a simplified means of accomplishing total mucosal visualization by trying to lessen the extent of the procedure and employing a rather inexpensive instrument in so doing.

In 1955 Leonard and Lady [6] (George Washington University Hospital) devised an ingenious instrument which consisted of a Lucite tube with a mirror reflector attached. It was designed to permit examination of the cervix. It soon became evident that the use of various types of Lucite tubes might have distinct



A B C

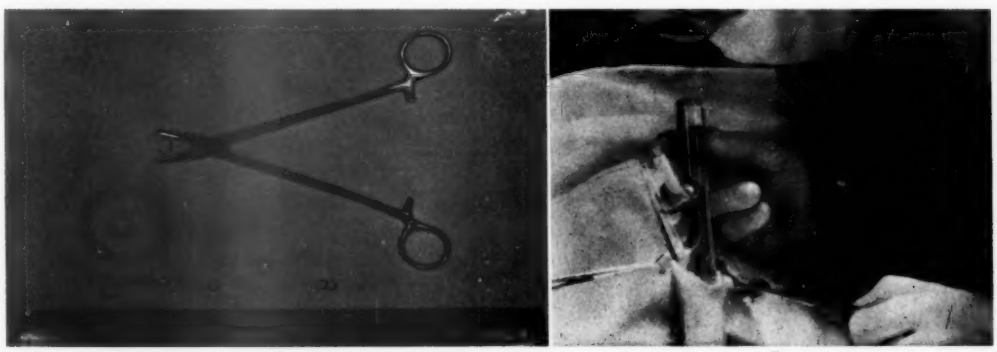
FIG. 1. A, two Lucite tubes are shown. The larger tube is 30 cm. in length and 2.5 cm. in diameter. This tube can be employed in adult humans. The smaller tube is for use in children and in the experimental dog. B, the Lucite tube is submerged in a cup filled with coffee. The camera mounted above will record how objects will be seen in the bottom. Note that the only source of light is that coming from the window. C, a penny is readily rocognizable as photographed by the camera as set up in Figure 1B.

advantages in many applications, particularly as a method of searching for minute polyps of the colon.

A Lucite tube was made with a small accessory tube extending at an oblique angle from the main tube. (Fig. 1A.) Light passed through this accessory tube from its exposed outer end would be transmitted down the length of the main tube illuminating the area at the opposite end. By looking through the straight arm, visualization of objects at the distal end is quite easy. Figure 1B depicts the tube with its end submerged in a cup of coffee. A penny is on the bottom of the cup. A camera through which visualization would take place is mounted above the proximal end. Figure 1C shows the penny as easily seen through the tube and recorded by the camera in Figure 1B.

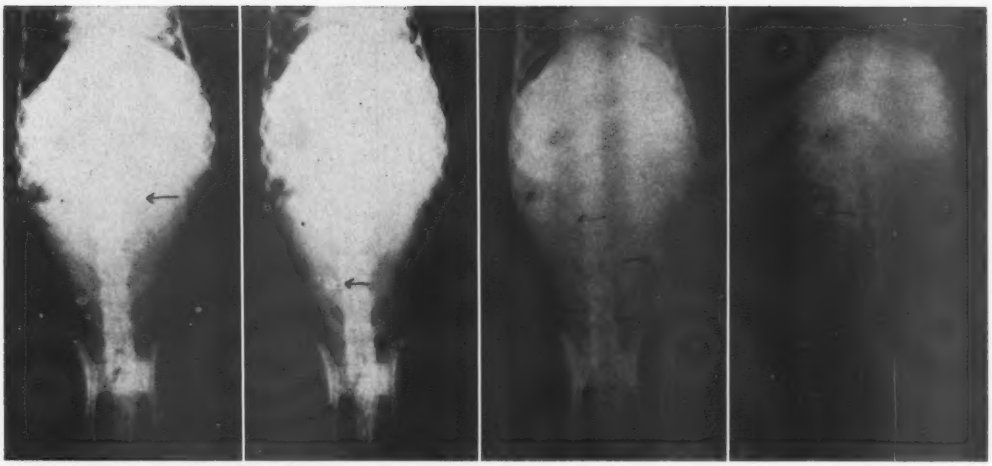
Since the tube is solid, no liquid material can obscure vision and solid feces can be pushed aside. The tube can be passed along the bowel without requiring inflation. The mucosa of the lumen can be pressed against the end of the tube for direct visualization. The fact that light can come from a remote source rather than from any inbuilt mechanism does away with the need for any wiring attachment and permits the operating theater to remain fully lighted.

In order to prove the value and applicability



A B

FIG. 2. A, a needle holder with a small metal clip held in the jaws in which a longitudinal groove had been cut. Small clips (one open, one closed and one doubled) are represented below. B, the method of employing the Lucite tube to examine the lumen of the bowel. Note that the room is not darkened and that the necessary light comes from a remote source.



A B

FIG. 3. A, roentgenogram on the left shows a single metal clip previously secured into the mucosal surface of the lumen of the bowel in the mongrel dog; the roentgenogram on the right shows that second clips have subsequently been applied to the first ones after they had been detected solely by means of the Lucite tube. B, roentgenograms of another of the ten mongrel dogs used in this double-blind study. This shows similar findings to those described under A.

of such a tube, a double-blind study has been carried out as follows: Laparotomies were performed on ten mongrel dogs and small openings were made in the bowel. A needle holder, the jaws of which had been grooved to hold a small metal clip, was introduced through the openings and the metal clips were secured to the mucosal surface. (Fig. 2A.) After this the bowel and abdomen were carefully closed. After a period of three months the animal was anesthetized and roentgenograms were taken to ascertain the location and number of clips present. Another operator, who had no knowledge of the number or location of clips, then opened the abdomen and attempted to locate all of the clips present by complete visualization of the bowel without palpation. Figure 2B shows introduction of the Lucite tube through an incision in the bowel. When a clip was found, an opening was made adjacent to the area. A second clip was attached to the original one with the needle holder.

After the operator thought that he had adequately searched the bowel, roentgenograms were taken postoperatively to ascertain whether or not all of the original clips had been discovered and a second clip applied. Figures 3A and B show that the single clips have been detected and tagged with a second clip in confirmation of this double-blind study. From one to three clips were introduced and all clips were recovered.

SUMMARY

A new instrument for the examination of the mucosal surface of the bowel is described. It presents experimental evidence that large areas may be explored for the detection of lesions that would not be revealed by conventional methods of examination, such as barium enema X-ray studies.

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Aids in Finding Adenomas at Laparotomy

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THIS paper aims to present, in the chronologic order of development, an evaluation of diagnostic maneuvers that have been utilized at laparotomy for the localization of adenomatous polyps of the colon which are situated above the reach of the conventional (25 cm.) sigmoidoscope. The large number of technics that have been proposed (and often abandoned) indicates dissatisfaction with many of the available maneuvers.

One of the oldest procedures is palpation of the intact colon with the thumb and index finger. This method may elicit the large lesions (over 1 cm. in diameter) that may be identified radiologically, but it frequently fails to detect the smaller lesions, particularly in the presence of moderate obesity. Infrequently, particles of feces are mistaken for intraluminal polypoid lesions (fictitious polyps).

Another method is extraluminal transillumination of the intact bowel by placing a condensed lighting system against one of the lateral walls of the bowel in the darkened operating room. In recent years this method has been superseded by internal transillumination, namely, by introducing the light into the lumen of the colon via the anal orifice.

Early in our experience, we utilized a flexible endoscope equipped with lenses for intraluminal exploration. (Fig. 1A.) After a prolonged trial in the experimental animal and the human, we have not been able to eliminate technical difficulties encountered with this endoscope and the mesenteric aspect of the colon could not be transilluminated. Therefore, even large polypoid lesions situated in this area have escaped detection.

We have recently been stimulated by the work of Foley and his associates [1] to reinvestigate the value of transillumination of the walls of the colon. We designed an instrument consisting of a long flexible but firm polyethylene tube and a lighting system of a 10 to 15 volt bulb which is attached to a recharging battery. (Figs. 1B, C and D.) This gadget is introduced into the ampulla by an assistant or a nurse and can be advanced easily under the guidance of the operating surgeon as far as the cecum. Even with this source of perfect illumination, we have not been able to overcome the problems encountered with the flexible endoscope. The small, polypoid, new growths on the lateral and antimesenteric walls of the bowel usually are not detected since they cannot be distinguished with any degree of certainty from the surrounding normal bowel wall even with the aid of this new instrument. The mesenteric aspect of the bowel resists transillumination and detection of even the larger lesions in this anatomic site. We have devised a flexible coloscope using fiber optics for clinical evaluation in the hope that this new scope may eliminate some of the difficulties.

We have investigated the effectiveness of intraluminally introduced illuminated Lucite via a small colotomy incision in dogs. We are still unimpressed with its diagnostic potential but we intend to extend this study after Gerwig has completed his investigation.

At present coloscopy with the conventional sigmoidoscope through small colotomy incisions is superior to the foregoing maneuvers. (Fig. 2.) Deddish and Hertz [2] believe that this procedure permits efficient inspection of the lumen of the large intestine and that it is associated with a low mortality and morbidity. They found adenomas which had not been diagnosed on radiography in 46.6 per cent of 103 patients. Furthermore, 40 per cent of these adenomas measured more than 1 cm. in diameter. These findings are not quite in conformity with our limited experience. The adenoma larger than 1 cm. in diameter has not been a problem to us

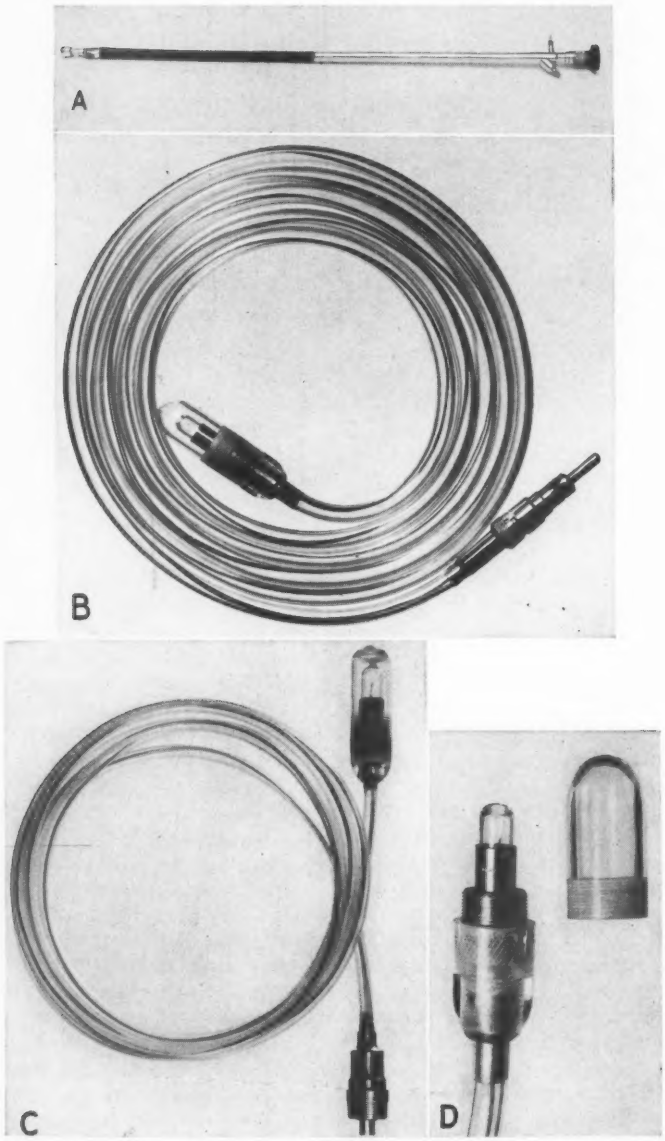

FIG. 1. A, flexible endoscope inserted into the colon via the anal canal and used for exploration of the lumen at the time of laparotomy; B, initial model of the illuminating instrument with a 4 volt bulb and polyvinyl tubing; C, the latest model with a 10 to 15 volt bulb and polyethylene tubing which is firmer than polyvinyl plastic material and makes the orad advance of the lighting system easier; D, magnification of the lighting system of C.

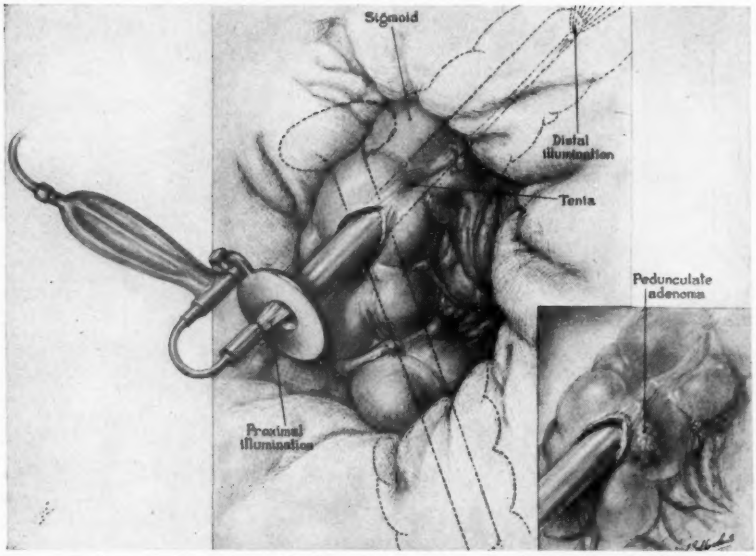

FIG. 2. Endoscopic inspection of the lumen of the colon proximally and distally through a small colotomy incision with the Turell sigmoidoscope.

since the roentgenologists almost invariably spot these lesions. Preoperative roentgenologic detection of the smaller lesions is the crucial issue. Coloscopy through colotomy has revealed previously unsuspected, at least roentgenologically undiagnosed, adenomas. However, at necropsy of two cases in which examination was performed less than a fortnight from the time of operation, additional small adenomas which had been missed at the time of the original coloscopy have been observed. This limited but important observation which is seldom reported points up an important deficiency of transcolonic endoscopy performed at the time of operation.

Dissatisfied with conventional coloscopy at laparotomy, Shackelford and McGeehan [3] have developed a modified technic by adding insufflation of a small quantity of air. This improved technic distends the colon with air, flattens out any existing folds of mucous membrane and helps to detect small, otherwise hidden, new growths and ulcerations. Our recent study of dogs indicates that coloscopy with air insufflation is superior to conventional coloscopy without air distention and much more reliable than palpation through the intact colon wall, or extraluminal or intraluminal transillumination. In the human this procedure is time consuming.

In our continued search for the ideal method of examination of the lumen of the colon we next studied the value of extended colotomy as described by Gants, Raymond and Pope [4]. The entire length of the colon has been incised and sutured experimentally (in the monkey) without incident. Peristalsis became active immediately after operation. The colon was neither distorted nor shortened when examined six to twelve months after operation. In humans incisions varying in length from 6 to 10 inches (15 to 25 cm.) have been made on the antimesenteric border (taeniae) of the ascending, transverse and descending segments of the large intestine. The mucosal surface thus became available to direct inspection. By evaginating the bowel wall adjacent to the incisions, unincised segments of the bowel of varying length could be brought into view with ease. Gants et al. closed these incisions in two layers. A continuous interlocking No. 3-0 catgut suture was followed by a second row of interrupted Lembert sutures using No. 4-0 fine silk.

We have repeated this work experimentally in dogs by incising the entire length of the colon and closing the wounds with only one layer of interrupted No. 4-0 silk sutures. The sutures were introduced in the entire wall of the bowel at the edge of the wound at intervals of about

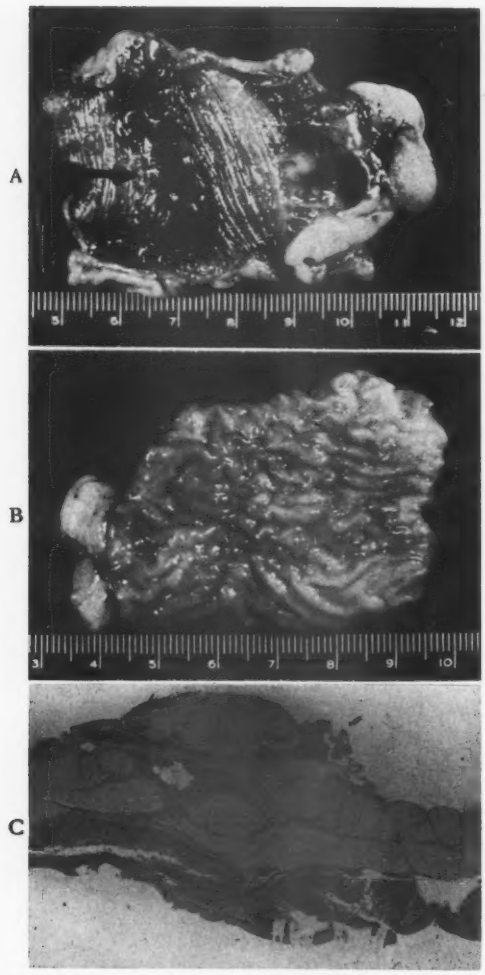

FIG. 3. A, gross appearance of the wound five days after construction of the anastomosis; B, gross appearance of the wound three weeks after operation; C, microscopic appearance of wound in B.

3 mm. Healing was uneventful (Fig. 3) without narrowing of the lumen as determined postoperatively at various intervals of time. A two-layer closure with absorable and unabsorbable sutures has been utilized to date in humans. We have not yet resorted to a U-shaped incision from the cecum to the rectosigmoid but have utilized incisions of variable lengths. (Fig. 4.)

This procedure enables one to visualize additional adenomas that are missed by preoperative radiography, palpation of the intact bowel,

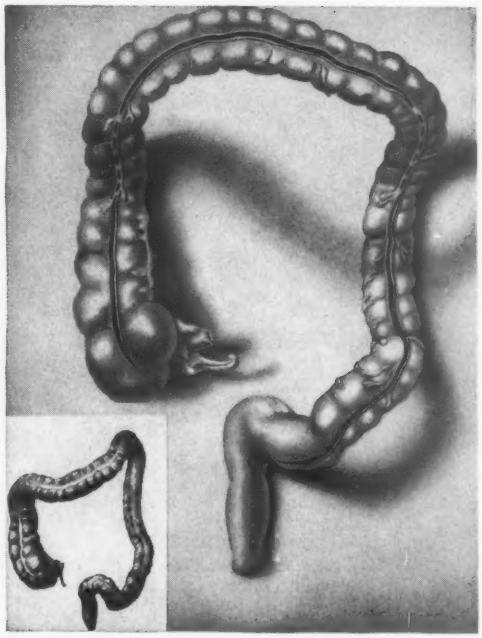

FIG. 4. Incision in the taeniae. Dotted lines indicate unincised areas which may be incised to complete a U-shaped incision from the cecum to the rectosigmoid. Insert shows the normal anatomic position of the colon prior to mobilization.

digital exploration through colotomy incisions, transillumination of the intact bowel wall by means of extraluminal or intraluminal lighting systems, and coloscopy through small colotomy incisions without air insufflation. Extended colotomy is also useful in determining emphatically the absence of true adenomas after a mistaken (presumptive) radiographic diagnosis (fictitious polyps) leads to surgical intervention. The colonic mucosa is visualized well so that the presence of mucosal excrescences can be recognized at a glance. Small discrete, benign or malignant ulcerations which may escape detection when the other previously mentioned diagnostic procedures are utilized can be visualized easily. (Fig. 5.)

In one instance, a diagnosis of pedunculated adenoma was made roentgenologically and confirmed by palpation of the intact colon. A colotomy incision 10 cm. in length was made in the area of the adenoma and also revealed an unsuspected small ulceration located about 5 cm. cephalad to the adenoma. Therefore, a resection of the bowel was performed. Histologic

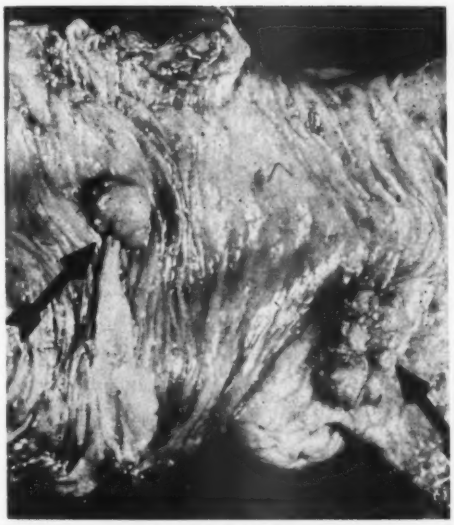

FIG. 5. Arrow at the right shows a small unsuspected malignant ulceration.

examination revealed the ulceration to be an invasive adenocarcinoma.

In another instance, in a white, moderately obese, seventy-seven year old woman who was considered a poor surgical risk by the cardiologist, a sessile adenoma with noninvasive malignancy on the anterior wall 12.5 cm. from the anal verge had been disposed of by electrothermia. The second series of yearly follow-up roentgenograms revealed two polypoid lesions near the cecum and another in the splenic flexure. Although her cardiac status was considered precarious, a subtotal colectomy with a low ileorectal anastomosis had, nevertheless, been scheduled. At operation an extended colotomy was made in the ascending colon close to the cecum. Two sessile adenomatous polyps larger than 1 cm. in diameter were readily seen along with two smaller ones less than 0.5 cm. in diameter. Evagination of the entire cecum revealed another large adenomatous polyp that had been missed on inspection and on intraluminal digital palpation. Palpation of the adenomas yielded an impressionable firmness distinctly different from the stony hardness of an infiltrating cancer, and they were easily movable with the adjacent mucosa for a considerable distance showing a decided absence of fixation of both the lesion and the adjacent mucosa. Because of the patient's precarious general condition, these lesions were excised *in toto* at the base, and the specimens were found to be benign on histologic examination by frozen section. We ordinarily eschew this technic because the best pathologists have been deceived in both directions [5]. Evagination of the bowel for a considerable distance proximally and distally from the incisions failed to reveal additional polyps. The splenic flexure was then freed and an extended colotomy was made. As elicited on radiography, only one pedunculated

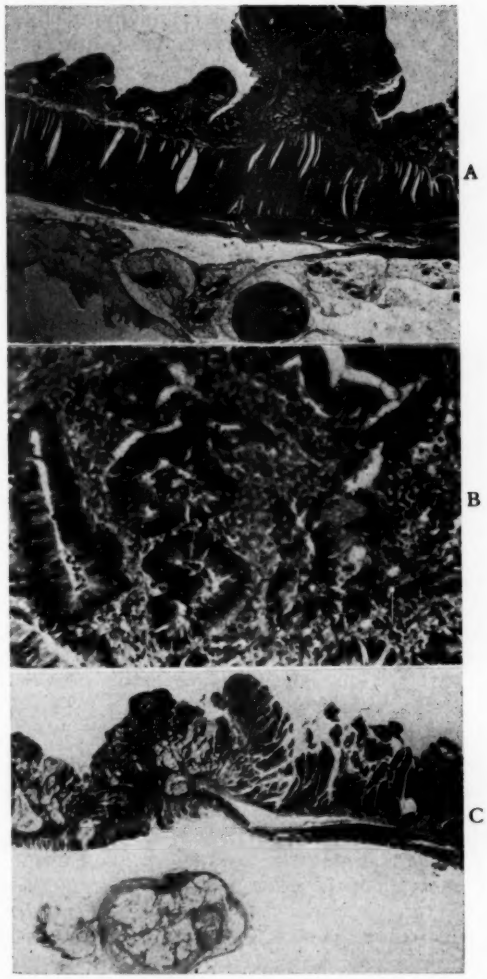

FIG. 6. A, sessile adenoma with cytologic (noninvasive) malignancy and a benign palpable mesenteric lymph node; B, microscopic appearance of A; C, benign sessile adenoma with palpable benign mesenteric lymph node (see text).

adenoma which was grossly unquestionably benign was found. It was then decided to close the colotomy incisions and to forego a subtotal colectomy. The patient made a relatively uneventful recovery.

In this instance extended colotomy emphatically proved the presence of additional adenomas, enabled a rapid histologic verification of the clinical impression of the benignity of sessile adenomas in the cecal area, disclosed an adenoma that was temporarily missed on inspection and intraluminal digital exploration, and made possible a more rapid conclusion of the surgical intervention. The foregoing should not be interpreted as an advocacy of extended colotomy versus subtotal colectomy.

In another instance, a local excision of a grossly benign sessile polypoid growth was effected through an extended colotomy because of the sudden change of the condition of the patient (complication due to anesthesia) soon after the abdomen was opened. The lesion proved to be benign.

In still another situation, although extended colotomy indicated that the intraluminal sessile lesion was benign in character, wide segmental resection of the bowel was performed because an enlarged mesenteric lymph node was found in the vicinity of the lesion. However, postoperative histologic examination revealed the intraluminal lesion and the lymph node to be benign. (Fig. 6C.)

As a matter of interest, but not germane to this thesis, Figures 6A and 6B show an intraluminal polypoid lesion and a palpable mesenteric lymph node. In this case the sessile adenomatous polyp was the seat of noninvasive cancer but the lymph gland was benign. Thus, palpation of mesenteric lymph nodes alone is as unreliable as palpation of intraluminal lesions through an intact bowel wall.

In one case of multiple (nonfamilial) polyposis, one large sessile lesion was easily palpable through the intact bowel suggesting a possible diagnosis of cancer. Therefore, the lesion was visualized through an extended colotomy and appeared to be benign. Frozen section confirmed this impression. This pertinent information led to a conservative colectomy (without wide excision of the mesentery) similar to that performed for ulcerative colitis or other benign diseases.

SUMMARY

Our investigation of the value of the various aids in detection of polypoid new growths in the colon at laparotomy is still in progress. Because of our experimental work in dogs and limited clinical experience, we are presently inclined to use extended colotomy incisions in preference to, but not to the exclusion of, the other available diagnostic measures.

The construction of a practical, flexible coloscope using fiber optics has been progressing very rapidly. This instrument promises to be an important investigative tool for the detection of intraluminal colonic disorders when used via the anus or through a small colotomy incision at laparotomy.

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Adenomas of the Colon and Rectum

THEIR MALIGNANT POTENTIAL

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CANCER of the colon and rectum is one of the most prevalent cancers in the United States and appears to be increasing [*1–2*]. If studies of the annual incidence in selected areas can be applied to the country as a whole, one would expect about 80,000 cancers of the colon and rectum to be diagnosed for the first time during 1960.

Many clinicians have reported the belief that many cancers of the colon and rectum begin in benign adenomas. They have advocated the preventive excision of all adenomas. This view has been the prevailing one at the Hospital of the University of Pennsylvania on both the medical and surgical services.

A recent study [*3a*] by Spratt, Ackerman and Moyer of Washington University (St. Louis) challenges the widely accepted concept that adenomas of the colon are precancerous growths. These authors state: "The theory of the origin of adenocarcinomas of the colon within adenomatous polyps has little to support it. We can find no real evidence that adenomatous colonic polyps become infiltrating metastazing cancers of the colon. The observed frequencies of occurrence of minute infiltrating adenocarcinomas arising in nonpolypoid colonic mucous membranes are adequate to account for the annual incidence of carcinoma of the colon of forty-five per 100,000." These investigators have challenged us to review our own material and the reports of others to determine the malignant potential of adenomas of the colon and rectum.

The ideal test for the hypothesis that adenomas are premalignant lesions and that their removal reduces the mortality from cancer would be removal of adenomas in half of a statistically significant sample of patients with these lesions. An analysis of all the patients after a suitable time might then demonstrate the potential malignancy of adenomas and the value of their routine removal. The difficulties of such an ideal study are obvious, but it is possible that a method of testing might be found by a cooperative effort of the members of the Association for Colon Surgery.

Until a study of such nature is performed, the validity of the hypothesis that adenomas are precursors of cancers must rest on evidence that is circumstantial and indirect.*

EVIDENCE

Invasive Cancer in Otherwise Benign Adenomas. Spratt, Ackerman and Moyer state: "If cancer of the colon arose in adenomatous polyps the least one should expect is an occasional readily detectable residuum of the progenitor polyp in those carcinomas of the colon that arose in polyps. However, Helwig [*4*], after searching the twenty-five 'mainfest cancers' of the colon that he discovered at necropsy, wrote this: 'No informative data are gained from a morphologic study of the twenty-five examples of manifest carcinoma. In most instances the widespread growth had destroyed the initial architecture making it impossible to identify pre-existing adenomas.' Although Ackerman did not make a minute systematic search for residua of polyps in the 298 cancers of this series, he saw none and cannot believe that if they existed, they could have completely

* Papillary adenomas (villous papillomas) and the adenomas of familial polyposis are excluded from the discussion because there appears to be little controversy about the malignant potential of these special lesions. There is one notable exception. Turell [*3b*] maintains great reservations about the alleged greater malignant potential of villous adenomas.

TABLE I
COMPARATIVE LOCATIONS OF CANCERS AND ADENOMAS

Location	Adenomas* (Per cent)	Cancer† (Per cent)
Cecum and ascending colon	4	16
Transverse colon‡	3	5
Descending colon and sigmoid	30	32
Rectum	63	47

* 1,500 cases.
† 812 cases.
‡ Flexures are included.

escaped his vision. The failure to find recognizable polyp tissue in 323 cancers of the colon, and the discovery of only questionable instance of infiltration of the stalk by a 'cancer' arising in a polyp among 425 adenomatous polyps is rather peculiar should adenomatous polyps degenerate into infiltrating metastasizing cancers of the colon."

Experience at the Laboratory of Surgical Pathology of the Hospital of the University of Pennsylvania has not been identical with that described above. Dr. H. T. Enterline and Dr. George Evans [5] are in the process of reviewing all carcinomas of the colon and rectum as well as all adenomas which had been diagnosed as containing areas of carcinoma. Although the study is incomplete at the present time, Dr. Enterline has seen a number of carcinomas which, in his opinion, contain undeniable remnants of adenomas. From 1943 through 1958 adenomas were removed from approximately 1,500 patients and studied in this laboratory. Drs. Evans and Enterline have found that about 10 per cent of the excised polyps show areas of atypia and that at least 2.5 per cent show definite evidence of stromal or deeper invasion. In their opinion, this would be diagnosed as invasive cancer by almost all pathologists. A small number showed conclusive evidence of stalk invasion and involved the entire stalk and subjacent bowel wall in some instances. Although no metastases to lymph nodes were noted when the cancer was limited to the body of the adenoma (in agreement with Dr. Ackerman), instances of lymph node metastasis were found when the stalk was invaded without extension to the base.

We believe that the important fact is that all variations from metastasizing carcinoma to minor degrees of atypia within the polyp can be found in any large group of adenomas.

Similarity in the Distribution of Adenomas and Cancers. The site of adenomas removed from 1,500 patients from 1943 through 1959 are shown in Table 1. These were studied microscopically. Comparison of the location of 812 cancers of the colon and rectum resected at the Hospital of the University of Pennsylvania during a period of twelve years (1940 to 1951) also are listed [6]. The distribution of adenomas and cancers is similar. Cancer predominates in the cecum and adenomas in the rectum. The similar distribution of adenomas and cancers certainly suggest some causal relationship. If an adenoma in every location of the colon and rectum had the same malignant potential, and if all cancers developed from pre-existing adenomas, then one would expect identical distributions. It is difficult to see how one can assume the same malignant potential irrespective of location. A variety of factors might be at work. For example, the chemical environment in different segments of the bowel might be involved.

In this series of adenomas a change in the distribution was noted when those removed during the first eight years (234 cases) were compared to those removed in the second eight years (1,266 cases). In the second series only 7 per cent were proximal to the descending colon; in the first series 12 per cent were proximal to the descending colon. Periodic health examinations have included sigmoidoscopy in the Diagnostic Clinic of the Hospital of the University of Pennsylvania since 1951. We believe that more frequent use of this examination as a routine method in the study of patients with gastrointestinal complaints might account for the increase in the percentage of adenomas excised from the distal large bowel and rectum.

Five times as many patients had adenomas resected in the second period of eight years as compared to the first period of eight years. Only twice as many patients were operated on for all causes. Possible explanations for this increase, in addition to the factors listed above, include more roentgen examinations of the colon and better technics for their performance, and an increasing belief that polyps should be excised in almost all instances. For example, Dr. Kendall A. Elsom, the Director of the Diagnostic Clinic of the Hospital of the University of Pennsylvania, states [7] that

almost all patients who have a polyp found in the periodic health examinations conducted in the Clinic are advised to have it removed.

Frequency of Adenomas Found in Association with Cancers of the Colon and Rectum. In our experience adenomas of the colon and rectum are present more often in patients who have a carcinoma of the bowel than in patients in whom no carcinoma is found. About 20 per cent of our patients with single carcinomas had associated polyps. Associated adenomas were present in ten, in a group of twenty-one patients who underwent resection for multiple primary carcinomas, an incidence of almost 50 per cent [8].

Development of Carcinoma at the Site of a Supposed Adenoma. We have observed very few patients who did not undergo surgical intervention after an adenoma was found by inspection through the sigmoidoscope or by roentgenographic examination. In some of these, however, what appeared to be a typical adenoma later proved to be a frankly invasive, metastasizing cancer.

COMMENTS

The evidence cited has convinced us that invasive cancer does develop in some adenomas of the colon and rectum. In the past we may have overrated the incidence of malignancy in adenomas. Since we have performed more routine proctosigmoidoscopies and thereby found and removed a larger number of adenomas through the anal canal, the incidence of invasive cancer arising in adenomas has decreased. A careful microscopic examination of adenomas removed from 1,500 patients in the last sixteen years has shown an incidence of invasive carcinoma of 2.5 per cent, and, in at least some, evidence that frankly invading and metastasizing cancer developed on this basis. This evidence alone forces us to view adenomas as potentially malignant.

The controversy over whether a benign adenoma becomes malignant or whether it is an adenoma that is malignant from the start seems to matter very little in the management of a patient with a polypoid lesion of the colon or rectum. Microscopic examination is the only way to establish the presence or absence of cancer. Therefore, all polyps of the colon and rectum should be removed when discovered if the patient's general condition is such that the risk of the surgical procedure involved is reasonable. Fortunately, the majority of polyps can be removed safely without laparotomy and do not pose a great problem in surgical management. If polyps are found in elderly patients or in patients for whom surgery involves great risk for other reasons, fine judgment may be required. Rhoads [9] has proposed a formula for use in preventive surgery as follows: M = percentage of operative mortality, I = percentage of benign lesions, C = percentage of cancer incidence, S_1 = five year survival rate after preventive surgery (per cent), S_2 = five year survival rate after therapeutic surgery (per cent), and MI = loss due to preventive surgery. Then the ratio $\frac{C(S_1 - S_2)}{MI} > 1$ is a necessary condition for preventive surgery. From our experience with adenomas we might estimate the following values for the symbols: I = 90, C* = 5.0 per cent, S_1 = 95, and S_2 = 45. Application of the formula would then be: $\frac{5(95 - 45)}{M\ 90} > 1 = \frac{250}{M\ 90} > 1$. The mortality of operation should then be under 2.8 per cent to justify preventive surgery.

However, in the application of this formula, we did not include polypoid lesions which were diagnosed as adenomas preoperatively and as frank cancers on pathologic examination. This should raise the mortality which would justify operation.

The fact that we have found no instance of metastasis when cancer was limited to the *body* of a pedunculated adenoma without invasion of the stalk does reassure us when we do not perform a segmental resection under these circumstances.

SUMMARY

We have evaluated the experience with adenomas of the colon and rectum at the Hospital of the University of Pennsylvania. In some instances frankly invading and metastasizing cancer appeared to develop from adenomas. All variations from invasive, metastasizing carcinoma to minor degrees of atypia within the polyp can be found in any large group of adenomas. Although not noted when cancer was confined to the body of a pedunculated adenoma, metastases have been demonstrated

* An estimate: two times the incidence of invasive cancer; one-half the incidence of atypia.

when the stalk was invaded even though the base of the stalk remained free of invasion. A malignant polyp can be absolutely differentiated from a benign polyp only by microscopic examination. For this reason all polyps should be excised *in toto* and examined microscopically. Unless the operative risk is prohibitive we advise removal of all adenomas of the colon and rectum.

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Panel Discussion

I. ADENOMAS OF LARGE INTESTINE AND THEIR MALIGNANT POTENTIAL

JONATHAN E. RHOADS, *Moderator*

JONATHAN E. RHOADS (Philadelphia, Pa.): Dr. Hayes will begin the discussion and Dr. Fitts will extend his previous remarks.

MARK HAYES (New Haven, Conn.): Let us consider a problem that may confront any of us in our practice. I refer to the management of the giant villous adenoma of the rectal ampulla. This has always presented a problem in management.

We have treated a couple of dozen of these in the last few years. Dissatisfaction with the technic of multiple biopsy and multiple fulgurations caused us to try a different technic in the treatment of these lesions.

It has been estimated that about 10 per cent of giant villous adenomas are malignant. Of the last eighteen that we have treated, two were malignant. The procedure is begun with caudal or spinal anesthesia, and about twenty minutes are spent to dilate the anal ring adequately and gently until acceptable retraction can be obtained. Total excision has then been performed following the method of Rehn-Dolorme. A very good cleft is found between the mucosa and the muscularis in the submucosa, and a primary closure is performed after excision. Two layer closure of the submucosa and the mucosa is used without difficulty.

The ease of the operative procedure is determined by the adequacy of the dilatation achieved prior to the exposure. We have treated some adenomas which have been completely circumferential and some that have extended from 2 cm. to 10 cm. above the anal verge. This makes it possible for a pathologist to pin the specimen out on a card, fix it *in toto* and study multiple sections for us. We found that the plane for the dissection of the mucosa off the muscularis was difficult in the two malignant adenomas. In each case it was a little sticky in one spot. That area was sent to the pathologist as a separate specimen and he reported it to be an infiltrating adenocarcinoma. These cases were subsequently followed with a combined abdominoperineal resection of the rectum. This has been a very useful technic in our hands.

JONATHAN E. RHOADS: How high in the rectum can one excise these lesions and perform an adequate suture through the anus?

MARK HAYES: This is not a complete resection of the wall. It is just a submucosal dissection avoiding the muscularis. The largest one we have removed extended from the level of 2 cm. to 10 cm. up and it was delivered down to the anal ring for the closure. If one uses gentle traction, one can produce a procedentia or prolapse of the rectum.

JONATHAN E. RHOADS: Does anyone believe that he can work much higher than 10 cm. through the anus?

WILLIAM T. FITTS, JR. (Philadelphia, Pa.): No, I have not. In some instances we have excised the coccyx through the posterior rectal wall for lesions of this type. It has been our experience that this lesion, which we call a *papillary adenoma*, has an incidence of malignancy of more than two of eighteen. I think that at least 40 per cent of the ones that we have excised have been diagnosed as carcinoma by the pathologists.

JONATHAN E. RHOADS: Moyer, Ackerman and Spratt exclude the lesions of which we are speaking from the category of polyps. They readily agree that this is a premalignant lesion which should be extirpated. The statistics on the degree of malignancy certainly vary in the literature. Biopsy of these tumors in several places often does not reveal malignancy. Yet, when the whole specimen is submitted to the pathologist, he may find that malignancy is present in some other area.

In my opinion, there is agreement that this

lesion should be extirpated. The majority of them seem to occur in the rectum or rectosigmoid. It is presumed that they may occur in other parts of the bowel. Two members of this organization have observed villous adenomas above the reach of the sigmoidoscope.

Conclusive identification by roentgenographic appearance would be difficult. If one ever decided to leave adenomatous polyps alone and subsequently encountered a shadow of polypoid nature on a roentgenogram, this would be a problem. He would either have to postulate that villous adenomas infrequently occur in that area and not be concerned, or he would have to perform exploratory surgery to determine whether the lesion was a villous adenoma or an adenomatous polyp. One would have a similar problem in regard to frank malignancy.

MARK HAYES: I recently got in quite an argument with a young house officer who told me that his professor believed that all these should be treated by abdominoperineal resection. I told him that he must have misunderstood and that these lesions should never be treated primarily by abdominoperineal resection without proof of malignancy.

He wrote to his professor and gave me the reply. I was rather surprised to find that, in this particular clinic, all villous adenomas of the rectum are treated by combined abdominoperineal resection of the rectum. This is not the case in Pennsylvania.

WALTER G. MADDOCK (Chicago, Ill.): Has Dr. Hayes experience been that the patients with lesions which were thought to be benign have lived long enough to substantiate his method?

MARK HAYES: This is an excisional biopsy and it is no better than the pathologist, Dr. Maddock. Our experience has been that we have not seen patients die of metastatic cancer from this during eight years of observation.

JONATHAN E. RHOADS: Do you wish to add something, Dr. Maddock?

WALTER G. MADDOCK: I have observed four patients with this lesion. Excision of the full thickness of the bowel with anastomoses was performed without recurrences. I have not used this particular method, but we should know about it if it is good; the experience of eight years should be important if the method seems to work.

ROBERT TURELL (New York, New York): I missed the first portion of the discussion. I want to bring up the question of villous adenoma to state that I, as far as the malignant potential is concerned, consider villous adenoma to be as dangerous or benign as the smooth adenoma. In my experience the incidence of malignancy has not been any greater than that found in smooth adenomas. There is one notable exception. At the initial examination, one finds more invasive cancer in a villous adenoma than in the smooth adenoma. Otherwise, I have not observed any difference between the malignant potential of the two lesions. I know there will be a lot of discussion and disagreement on this point. On my side of the argument, I have one man who is easy to lean upon, namely, Dr. Cuthbert Dukes, the pathologist of St. Mark's Hospital in London. Therefore, I would not employ a cancer operation for the treatment of all villous adenomas.

Fractional biopsy in adenomas is not only useless but dangerously deceptive. There is only one type of reliable biopsy, and that is *total* biopsy. Either the lesion is removed in one piece or in several large segments. This is necessary because tiny pieces of tissue, even if they are taken from several areas, do not provide information about the remainder of the polyp. One particularly does not know the condition of the deep portion of the polypoid lesion where the presence of a malignancy may be overlooked for some time.

This also applies to the treatment of adenomatous polyps by electrocoagulation on the basis of a histologic study of only a small piece of tissue or on the basis of the gross appearance alone. Thus, many weeks or months may elapse before the correct diagnosis is established. The removal of the entire lesion, either in one piece or several large segments, affords diagnostic value and therapeutic value when the polyp is benign.

JONATHAN E. RHOADS: Dr. Turell, I would like to discuss a question which has troubled me from time to time. Sometimes one removes a polyp *in toto* through a proctoscope. It is sent to the pathologist, and he reports (perhaps three or four days later) that there is a carcinoma which may involve the pedicle. Then one performs proctoscopy again and the bowel wall is healed completely so that it is impossible to find the site of the original lesion. Have you ever had such an experience as this?

ROBERT TURELL: Yes.

JONATHAN E. RHOADS: How do you avoid

this, or do you believe that you can simply resect on the basis of the level at which you performed the biopsy?

ROBERT TURELL: There is no single solution to the problem. If you remove the entire lesion, if the adenoma has a pedicle, and if you find cytologic malignancy only in the body, there is very little to worry about. If the pedicle is involved, treatment depends on the site of involvement.

One patient whom I treated had a pedunculated adenoma with malignant involvement of the pedicle near the body, but a sufficient quantity of pedicle remained for histologic examination. Therefore, it could be ascertained that the remainder of the pedicle was uninvolved. This patient has been followed up for over six years and there has been no recurrence to date. A long pedicle is good insurance against local recurrence, but, as stated by Welch, it does not guarantee freedom from distant metastases. However, the latter possibility must be very rare, because there is only a small number of reported cases in the world literature.

If the adenoma has a long pedicle and if only the body or a portion of the pedicle near the body is involved, I do not worry about it as long as the remainder of the pedicle is free from involvement. However, it is very important to secure serial sections of the remainder of the stalk.

JONATHAN E. RHOADS: Dr. Fitts, do you have any comments on the problem of how to remove all of a polyp and yet determine its location in case you want to do something more, or do you believe that this problem never arises?

WILLIAM T. FITTS, JR.: The problem has arisen a number of times in my experience, Dr. Rhoads. You may recall that Dr. Richard Bush of Boston, developed a technic of injecting India ink at the site of the removal of a polyp with this in mind. As far as I know this practice was effective. Dr. Turell and I have written to Dr. Bush within the last two years. He apparently is no less enthusiastic about the method because of the risk of perforating the intraperitoneal colon with the tip of the needle.

I would like to emphasize what Dr. Turell said about the importance of having the *entire* adenoma excised for microscopic examination. I believe this strongly and have practiced it for several years.

In reviewing all of the cases of pedunculated adenomas excised at our hospital during the last sixteen years, the pathologists have not found instances of metastasizing cancer as long as the cancer was limited to the body of the polyp without invasion of the stalk.

MARK HAYES: The reason the polyp has a pedicle is that peristalsis pulls it out and along the submucosa. I believe that invasion of the pedicle constitutes submucosal invasion, and I think we ought to stop hedging. If there is invasive cancer in the stalk of a polyp, there is submucosal invasion of a polypoid carcinoma of the colon. It is no longer a polyp. This is invasive cancer. I believe very strongly that histologic indications that the base of the polyp is not involved give no assurance whatsoever as to the status of the lymph nodes in the region of the colon. We pray and pray and pray for the early diagnosis of cancer and when we find one early we do not know what to do with it. Invasion of the stalk, a break in the basal membrane or invasion of the lymphatics indicate early cancer which should be treated by the most adequate form of an operative procedure at our disposal.

JONATHAN E. RHOADS: When one requests sections, particularly frozen sections, at operation on a polyp, how do the pathologists cut the stalk? Do they cut it horizontally across the base to see whether or not it is gone near your line of resection, or do they cut it longitudinally to see whether there is any invasion?

MARK HAYES: They cut it transversely at the base and longitudinally out at the tip. We do not use frozen sections on polyps.

JONATHAN E. RHOADS: That leads to another question. When you perform transabdominal polypectomy, do you always perform a resection or do you sometimes use colotomy and excision?

MARK HAYES: I perform colotomy and excision. If cancer is present, I reoperate.

JONATHAN E. RHOADS: You do not use frozen section?

MARK HAYES: No, sir.

JONATHAN E. RHOADS: Dr. Turell, do you use frozen sections in transabdominal polypectomy?

ROBERT TURELL: We do so only in exceptional cases.

JONATHAN E. RHOADS: How do you recognize the exception?

ROBERT TURELL: The patient previously discussed was an elderly woman who was in poor physical condition. The polyp appeared to be benign grossly, and it felt benign. However,

the pathologist was asked for additional microscopic confirmation. Our pathologists are reluctant to determine the histologic character of adenomas solely by frozen section technic. They realize that they can be deceived in both directions. What is thought to be benign may be malignant (and vice versa) in the paraffin or permanent sections. When one elects to take this calculated risk, the risk should be calculated before and not after the operation, and frozen section examination of unfixed tissue may be made.

JONATHAN E. RHOADS: Granted that the pathologist cannot diagnose carcinoma *in situ* accurately on a frozen section, is there any reason why he cannot diagnose invasive carcinoma of the polyp by frozen section as readily as invasive carcinoma from another lesion?

ROBERT TURELL: There is no apparent reason. At present, we must depend on their diagnosis, philosophy, training and attitude. In case of the slightest doubt, however, a segmental intestinal resection should be performed at the time of the initial operation rather than at a second operation at a later time.

JONATHAN E. RHOADS: Do you usually perform segmental resections when you perform transabdominal polypectomy?

ROBERT TURELL: No. But when there is a suspicion of malignancy or sessile polyps, I do. In the case of pedunculated polyps, sound clinical judgment determines the action. A physician who has palpated a benign and a malignant prostate knows that the benign prostate feels impressionable whereas the malignant one feels stony hard. A polyp that is extensively invaded by cancer also has a similar stony hard consistency. A benign adenomatous polyp is impressionable to palpation. A small circumscribed area of malignant involvement within the body also can be palpated occasionally. However, it is wiser to resect the tumor-bearing segment of the gut once the abdomen has been opened.

JONATHAN E. RHOADS: I used this method recently, and I think that it can be as hazardous as conservative measures. A small bowel obstruction developed in an elderly woman due to an adhesion to the suture line. Colotomy might have produced the same problem, but this started a chain of events which caused a steady decline in her progress over about three months. She died.

I wish to direct a question to the panel. Is it safe to remove a polyp from a point as high as the proctoscope will reach, or are you hesitant to remove them from a point above where you think the peritoneum begins?

ROBERT TURELL: This depends on the experience of the endoscopist to a great extent. I remove them from a high point provided that the lesion can be visualized clearly. If I have to loop the polyp blindly, I do not remove it through the proctoscope. I use electrocoagulation to destroy a polyp *in situ* only in a poor risk patient or when the adenoma has an intraluminal protrusion of less than 3 or 4 mm. I coagulate it in several sessions with an electrode, but I secure multiple biopsies from many areas with a cold biopsy forceps.

JONATHAN E. RHOADS: Do you refer to lesions within the peritoneal cavity?

ROBERT TURELL: Yes.

JONATHAN E. RHOADS: Dr. Hayes, what is your opinion?

MARK HAYES: I agree, in general, with Dr. Turell. If I can visualize the lesion well enough to put the loop around the pedicle of the polyp, I have no hesitancy in going as high as the proctoscope will go. However, I limit myself to a point below where I think the peritoneal reflection might possibly be in treating a sessile polyp by this method.

JONATHAN E. RHOADS: Where do you think it might be in an adult?

MARK HAYES: Dr. Gray of Toronto has stated that it is 15 cm. from the anal verge in a patient in a head-down position. I happen to have spent a couple of years in the study of anatomy, and I know that there is great variation. I believe that it is safe to remove polyps through the proctoscope at this level. That is, it is safe in men.

JONATHAN E. RHOADS: Dr. Fitts?

WILLIAM T. FITTS, JR.: At the suggestion of Dr. Eugene Pendergrass we studied this problem by obtaining roentgenograms before operation after inserting silver clips at various points in the bowel through the sigmoidoscope. We then determined the proximity of the peritoneal reflection at operation. We found a mean of 12 to 14 cm. I worry about any method of excising a sessile polyp above this point, other than by laparotomy. A pedunculated one may be removed through the sigmodoscope but a sessile one should not be for the reason that we have mentioned; namely, it is so important to get a

good examination of the base of the polyp. I would not go above 14 cm. from the anal verge except in the case of pedunculated polyps.

JONATHAN E. RHOADS: Bleeding occasionally follows removal or biopsy of these lesions. I wonder whether members of the panel have seen hemorrhage from one of these endoscopic procedures severe enough to require transfusion. Dr. Turell?

ROBERT TURELL: Yes, I have. I try to be certain that the tendency to bleed has passed before the patient leaves the operating or the endoscopy room. The severe secondary hemorrhages that I have treated usually followed sloughing at the site of coagulation, and that sometimes presents a real problem. One cannot always coagulate more at a second procedure because the risk of perforation is high. Whenever indicated I transfused the patient and hoped. To date I have not regretted this policy.

JONATHAN E. RHOADS: Have you ever had to reoperate, that is operate transabdominally, for hemorrhage?

ROBERT TURELL: No.

JONATHAN E. RHOADS: Dr. Hayes, what has been your experience?

MARK HAYES: I have observed secondary bleeding. Perhaps I have had better luck than Dr. Turell. I have treated this through the sigmoidoscope and have been able to coagulate the bleeding point again with a suction tip connected to the Bovie apparatus. I have not had to operate abdominally to control the bleeding.

JONATHAN E. RHOADS: Dr. Fitts, have you?

WILLIAM T. FITTS: No, I have been fortunate. I have not had to perform abdominal surgery for any of these. On a few occasions internists have urged me to excise adenomas as an outpatient procedure, which I have resisted for this reason. I have seen patients brought back to the hospital bleeding enough to require transfusions after this was done as an outpatient procedure.

JONATHAN E. RHOADS: As far as I can remember, our patients have all stopped bleeding after a transfusion and, occasionally, further coagulation. I do not believe that we have had to perform surgery transabdominally. Has anyone here seen a patient who bled so much after a biopsy or a local removal that abdominal surgery had to be performed?

Occasionally one of these little tumors is a carcinoid. I wish to ask two questions. Suppose that a very small polyp, not over 5 mm. in diameter, is found and reported to be carcinoid. Secondly, suppose it is larger than 2 cm. What would you do in each case? Dr. Hayes?

MARK HAYES: For a carcinoid above the peritoneal reflection, I would perform resection. For carcinoid below the perineal reflection, I would perform posterior sleeve resection, or posterior proctotomy, and removal irrespective of the size.

JONATHAN E. RHOADS: Dr. Turell?

ROBERT TURELL: I excise rectal carcinoids locally if at all possible, unless an infiltrating malignancy is suspected. In the presence of a malignancy, it is usually too late for cure no matter what you do. One patient had tiny excrescence but had hopeless metastases in the liver on surgical exploration. I prefer not to coagulate but to excise carcinoids. By excision I mean the removal, not only of the polyp, but also surrounding mucosa and the underlying submucosa, because carcinoids are submucosal lesions. An abdominoperineal resection of the rectum is certainly the procedure of choice for the malignant carcinoid without distant (usually hepatic) metastases.

JONATHAN E. RHOADS: We treated a patient with this problem about a year and a half ago The patient was a man from Philadelphia who belonged to a firm that had regular periodic health examinations. These included proctoscopic examinations, and one of the younger members of the staff who performed these proctoscopies removed a little polypoid lesion which was about 4 mm. in diameter and coagulated the base. He sent it to the laboratory and it was reported to be carcinoid. It was within the rectum. This proved to be a problem. Should this otherwise healthy man have an abdominoperineal resection in an effort to avoid the risk of metastatic disease?

Our experience with carcinoid in the rectum has been relatively bad. They have frequently been malignant, and the pathologists have not had much confidence that they could tell from a biopsy of the initial lesion whether metastases would occur or not. We reviewed our own experience, and Dr. Theodore Enterline searched the literature. As far as we could determine there was none on record as small as 0.5 cm. that had metastasized, and only one reported in the literature that measured 1 cm. or less had metastasized. Dr. Waugh, what was the measurement of the smallest carcinoid you have seen which metastasized?

JOHN M. WAUGH (Rochester, Minn.): The smallest was reported about three years ago, and I believe it was a little larger than 1 cm. One node was involved. I think it is an ideal situation for the pull-through operation.

JONATHAN E. RHOADS: Dr. Fitts?

WILLIAM T. FITTS: One of my patients was in the series you mentioned, Dr. Rhoads, which Dr. Gerald Peskin has recently reported. This patient fortunately has done well. He did have a carcinoid smaller than the limits you mentioned, and I performed local resection. I did not perform an abdominoperineal resection of the rectum. This reinforces the importance of excising the entire lesion at the first procedure. If this man had waited several days to return or if we had not received the histologic report for several days, it might have been impossible to find the area that was biopsied.

QUESTION FROM THE AUDIENCE: May I ask the panel their opinion of the value of high levels of serotonin in evidencing metastasis of the malignant carcinoids?

JONATHAN E. RHOADS: Dr. Hayes, would you answer this question?

MARK HAYES: I do not think it is helpful until the invasion extends to the pulmonary side of the circulation past the liver. Then the endal acetic acid excretion in the urine is helpful. This has been true in our limited experience with it. We have not had any luck with the serotonin levels in the blood. Dr. William Abbott at Western Reserve is trying to measure them in the blood. He has had difficulty measuring it in the circulating blood.

JONATHAN E. RHOADS: Dr. Turell?

ROBERT TURELL: In going over the literature in preparation for review on colonic diseases and function, I could not find a single case reported in which high levels of serotonin have been obtained in malignant carcinoids of the rectum even though the rectum is the second most frequent site of extra-appendicial carcinoids. I have asked Dr. Warner, who has had considerable experience with carcinoids, and he could not find one in his own experience or in the literature.

JONATHAN E. RHOADS: Dr. Fitts?

WILLIAM T. FITTS: As Dr. Hayes said, I think that we have found it only when the carcinoid has metastasized to the pulmonary side of the circulation. Dr. Peskin told me that he has not seen a single instance of this syndrome produced by rectal carcinoids.

JONATHAN E. RHOADS: We reviewed the literature to get some statistics on survival after prophylactic removal of polyps of the large bowel which showed malignancy. These were all transabdominal operations. The risk in removing the polyp through the sigmoidoscope is so low that I do not think anyone would question it.

About 83½ per cent of the patients who had transabdominal removal of adenomas were alive five years after operation. I presume that the rate of survival would be even higher were it not for deaths from other causes due to advanced age.

The survival rate in our series among patients who have therapeutic removal of carcinoma of the colon is a little lower than the 50 per cent Dr. Fitts reported earlier, but this included all patients with carcinoma of the colon whether they were operated on or not. Five-year survivals averaged 33 per cent.

We reviewed the incidence of malignancy in polyps removed transabdominally. These are almost always 1 cm. or more in diameter but they are sometimes 0.5 cm. in diameter which is about as small as most radiologists can demonstrate. This averaged 21 per cent of 542 patients in a collected series. All evidence of malignancy, including carcinoma *in situ*, was included. If carcinoma *in situ* or grade 1 is excluded from this series, there were 26 among 362. The total is smaller because groups in which carcinoma *in situ* and invasive cancer were not distinguished were excluded. This group comprised 7.1 per cent. Grinnell reported a comparable figure of 5.7 per cent.

The mortality in transabdominal polypectomy has been low in these six series, and it seemed to me that they were reasonably representative series. They averaged 0.5 per cent. If we compare the 21 per cent incidence of cancer, 0.5 per cent mortality, 83 per cent five-year survival after prophylactic removal and 34 per cent for all colon carcinomas, and conclude that perhaps 30 per cent of these were going to have to be removed because they start to bleed for some other reason, we can calculate the gain as the difference in the five-year survival rates applied to the percentage that have cancer. The loss can be calculated as the mortality among those who would not have to be operated on if one was not trying to prevent cancer. The statistical evaluation favors removal of the lesion.

If one takes instead of 21 per cent, which includes the carcinomas *in situ*, the figure of 6 per cent, then that reduces it to perhaps an 8 to 1 advantage, and if one used a higher percentage of mortality it would rapidly reduce that advantage.

Perhaps Dr. Fitts would summarize the Ackerman and Moyer paper for us. As I understand it, they are not against removal of all polyps, but they are against very radical procedures to achieve this end, and they believe that the danger has been substantially exaggerated.

WILLIAM T. FITTS: The paper by Spratt, Ackerman and Moyer concerned us and stimulated us to review our material. We believe that this problem is one that involves the colon. If the polyp can be removed through the anal canal, the mortality and morbidity is almost negligible. If a colotomy must be performed to remove the polyp, I believe that sound judgment is required to decide for or against operation in a patient for whom surgery is a great risk.

The problem is that, if the polyp is situated above the level of the sigmoidoscope, a frankly infiltrating or invasive cancer may resemble a polyp on roentgenograms. At times it may look like a pedunculated polyp. In order to use Dr. Rhoads' formula, I think we would have to add a number of these lesions to the figures. This would give a somewhat stronger case for operation.

My belief has not been changed by this paper. Unless surgical intervention is a great risk for a patient or the life expectancy is short, a polypoid lesion must be excised for examination even if a laparotomy is required.

JONATHAN E. RHOADS: I must leave due to a complication in travel arrangements. Dr. Waugh will serve as moderator for the remainder of the discussion. Dr. Hayes and Dr. Turell, do you intend to continue to remove polyps transabdominally in the future?

MARK HAYES: When one reads an article like Dr. Carl Moyer's, which explodes the concept of the relation of malignancy and benign polyps, I think that one should make a new interpretation of the data to fit his own philosophy and to document his own attitudes. An advocate of scientific evaluation is the person who does not always agree with your conclusions but may well believe your data. I believe the data presented by Dr. Moyer and Dr. Ackerman, and I do not believe that they mean to alter our belief about polyps of the colon. My interpretation of their primary thesis is that benign adenomatous polyps do not become malignant. But I do not know how this can be proved.

Many physicians believe that they have observed polyps which became malignant (polypoid carcinoma). Dr. Coller mentions many cases of this. The patients refused operation and a true polypoid carcinoma developed. The argument is that it was malignant from the start and its growth potential changed. I must rely on the pathologist to tell me whether this particular polyp is benign or malignant. I will not change my opinion until someone proves that these lesions can be distinguished grossly.

ROBERT TURELL: I think the great contribution that Drs. Ackerman, Spratt and Moyer have made is that they have focused our attention on the differentiation between cancer in adenomatous polyps and polypoid cancer. We seem to forget that these are two different entities and we confuse them most of the time.

The statement has apparently been made by Ackerman et al. that they have never seen adenocarcinoma in an adenomatous polyp. We have seen an example of a lesion which had benign adenomatous tissue on each side, and a crater in the center which was a definite invasive cancer. I have seen a number of such cases. Repeated biopsies would fail to reveal the significant lesion in the center for a long time. On the other hand, there are examples to support Ackerman's position. I now have well over twenty patients with adenomatous polyps. In one case the lesions were diagnosed seventeen years ago and there is no evidence of malignant degeneration. The patients have refused removal of their adenomas and I frankly must admit that I am on the sideline with them because I want to see what will happen as long as the onus is on them.

One patient had a villous adenoma that remained benign for a long time. I saw her intermittently for a period of at least fifteen years. She died at the age of eighty-four of causes unrelated to the polyp. Necropsy revealed that the lesion was still benign. With increasing experience I have come to believe more and more in the thesis that benign adenomatous polyps will not undergo malignant degeneration during the lifetime of the average patient. Of course, I cannot prove this.

Villous adenoma, like its counterpart (the

smooth adenoma), can be completely benign or it may be the seat of noninvasive malignancy. As I have stated early during this discussion, with one notable exception, the malignant potential of villous adenoma is the same as that of the smooth adenoma.

The problem in the treatment of a polypoid cancer is that we do not readily distinguish the difference between a polypoid cancer and cancer in a polyp. The roentgenologists are frequently responsible for this misconception. If the roentgenograms suggest the presence of a polypoid lesion, we must presume that we are dealing with a polypoid cancer rather than a benign polyp and treat it accordingly. A therapeutic decision should not be made solely on the basis of the size of the lesion as seen on the film.

JOHN M. WAUGH: I think it would be interesting to the panel to see a show of hands as to the number in the audience who have seen (perhaps because a patient refused operation) an infiltrating cancer which developed in the identical area of an adenoma. How many of you have seen such a lesion? Anyone? I guess I am the only one.

If Ackerman and Moyer have done nothing else, they have done a wonderful job in making us all consolidate our thinking. I think that in discussing this recently in Indianapolis it was pointed out that the mortality cited by Moyer may be a bit high for transcolonic excision. I believe that he stated it to be 2 per cent. The incidence of cancer in the polyps which he treated was probably lower than that in our groups. Those two factors would alter their figures considerably. It is bound to vary with the pathologist. I believe that a surgical pathologist must be willing to train himself to be expert in frozen section technics. Surgeons must insist on a quick method of identification. If they know that they have to learn that technic so that you can rely on them, I think you will find that they will.

Are there any other questions from the audience?

QUESTION FROM THE AUDIENCE: Dr. Waugh, I would like to ask the panel what procedure is advisable for the treatment of multiple polyps which are not familial or congenital polyposis.

JOHN M. WAUGH: That is a good question. Under what circumstances do you advise subtotal colectomy and ileoproctostomy rather than multiple colotomies and excisions? Dr. Turell?

ROBERT TURELL: When three to five polyps in different segments of the colon are noted on roentgenogram and are beyond the reach of the sigmoidoscope, I would advise subtotal colectomy and ileoproctostomy provided the patient is in good physical condition. I think one may safely multiply this figure by three or five and you would probably be right. In other words, in the absence of systemic contraindications, a subtotal colectomy should be performed when more than three polyps are discernible.

JOHN M. WAUGH: Dr. Hayes?

MARK HAYES: We have devised a program, but we are not ready to evaluate it yet. I believe that any patient who has survived a carcinoma of the colon five years or more and develops a subsequent polyp should have a total colectomy and ileoproctostomy. It must be an end-to-end anastomosis so that nothing can develop behind the anastomosis.

I agree completely with Dr. Turell, that if a patient has multiple polyps distributed throughout the colon and is a good surgical risk the same operative procedure should be performed rather than multiple operations for the removal of polyps.

WILLIAM T. FITTS: I believe the panel agrees on this question, Dr. Waugh. We have seen many of these patients who had multiple polyps removed and multiple carcinomas or at least one carcinoma subsequently developed. We believe that such a patient is very apt to have difficulty and although I cannot say categorically how many polyps should be present before a colectomy would be advisable, I believe that our records show that we have tended to perform more colectomies for multiple polyps in the last several years.

QUESTION FROM THE AUDIENCE: What is your opinion about the same case in children who have multiple polyps?

WILLIAM T. FITTS: Although I have not had much experience with the juvenile polyp, I am not talking now about familial polyposis but about the "juvenile polyp." In our experience these have always been benign lesions and have not become malignant. We certainly would not advise colectomy for them.

QUESTION FROM THE AUDIENCE: One child (a boy) has come into the hospital on several different occasions (ten or twelve) for removal of a benign polyp. Subsequently, four or five more polyps developed which were seen by

sigmoidoscopy and on roentgenograms after barium enema. The polyps were removed through two or three colotomies. Would you continue to perform colotomy in this situation if polyps continued to develop or would you perform subtotal colectomy?

WILLIAM T. FITTS: Were these microscopically adenomas—adenomatous polyps—or were they juvenile polyps?

REPLY FROM THE AUDIENCE: They were microscopically juvenile polyps.

WILLIAM T. FITTS: Dr. Koop has followed the progress of some of these at Children's Hospital in Philadelphia. It is my understanding that he has not found the later development of cancer in any of these patients. I have not had enough experience to answer that.

HARVEY E. KNOERNSCHILD (Columbus, Ohio): We have devised a method, which we have used since January 1960 to determine the site of a treated polyp. A tattooing machine which is inserted through the sigmoidoscope is used to mark the base of the polyp. We have followed up two cases for four or five months and the tattoo mark is still there.

JOHN M. WAUGH: Is there more comment concerning juvenile polyps? Dr. Turell?

ROBERT TURELL: An adult type of adenoma is sometimes encountered in a child and vice versa.

MARK HAYES: These have become adenomatous?

REPLY FROM THE AUDIENCE: I believe that they have. I am not sure of that.

MARK HAYES: I think the roentgen hazard becomes significant in children on the basis of an annual barium enema, and I worry about the subsequent results of the radiation dosage to the posterior lymph nodes of the abdomen. If the follow up and the repeated operative procedures become difficult enough, I think it is preferable to put the colon under direct visualization, by subtotal colectomy. However, I think that children do not tolerate a subtotal colectomy nutritionally as well as adults. Growth and development may be affected. We have treated two such children who have had nutritional problems which were not caused by diarrhea. Some unknown factors that we are not able to explain were involved.

JOHN M. WAUGH: I think we should draw this panel to a conclusion.

II. CANCER OF THE RECTOSIGMOID

JOHN M. WAUGH, *Moderator*

JOHN M. WAUGH: I believe that there are five or six questions that all of you would like to ask, so I took the liberty of sending these questions to the members of the panel. The first question is, do each of these men favor sphincter-saving operations for carcinoma of the rectosigmoid? If so, what are the indications for their use and what type of a procedure should be used? Dr. Maddock?

WALTER G. MADDOCK: I favor sphincter-saving operations under certain conditions. The rationale for the sphincter-saving procedure is based on pathologic studies which demonstrate that carcinoma of the rectum does not extend along the bowel for a distance of much more than 2 or 3 cm., and that extension to the peripheral lymph nodes is very unusual unless the lymph nodes above the site of the lesion are blocked. There have been sufficient studies in the past, probably six or seven hundred cases at least, that have been very thoroughly reviewed by pathologists. Metastases to lymph nodes has been found distal to the carcinoma only thirty or forty times. When these instances are reviewed one finds that almost all of them were found within 1 to 2 cm. of the lesion. There are very few cases of any lymphatic extension below the lesion, except when the condition is a hopeless one due to blockage of lymphatics above.

The procedure which I prefer to perform for carcinoma of the rectosigmoid area is the anterior resection with ligation of the inferior mesenteric artery at its origin from the aorta and of the inferior mesenteric vein as it passes under the duodenum. This procedure includes removal of the upper half of the rectum, the sigmoid and possibly some of the descendens, along with all the adjacent mesentery down to the great vessels. Finally, an end to end

anastomosis is performed between the descending colon or splenic flexure of the colon, after mobilization, with the mid-rectum. For lesions of the upper half of the rectum one should resect lower, yet a sphincter-saving operation often is possible. When it is feasible to do so, I operate through a combined abdominoperineal approach using wide excision as previously described. The anastomosis is performed through the perineal wound. This is not a new idea, of course; it is an old operation. One should divide the bowel and adjacent tissues 5 to 6 cm. below the tumor, and I leave at least 1½ to 2 inches of rectum in place so that sphincter function will be practically normal.

JOHN M. WAUGH: Dr. Gerst?

GEORGE R. GERST (New York, New York): The background and rationale of the procedure more or less portrays my own belief. That is, intramural spread distal to the lesion and lateral lymphatic spread occurring late in the course of the disease. The question arises as to what type of procedure one should use—whether one should use the anterior resection, the so-called pull-through procedure or one of several other procedures. I think there will be a difference of opinion about that. I believe that sphincter-saving procedures have a value and may be used more frequently in the future.

JOHN M. WAUGH: Dr. Poth?

EDGAR J. POTH (Galveston, Texas): Essentially, I am in agreement with what has been said. One consideration I use to determine whether or not there is distal spread is determination of the relative fixation of the tissues around the lesion, not absolute fixation which of course would indicate a hopeless situation. A segment of distal rectum not shorter than 4 to 6 cm. should be left if continence and control are to be preserved. I believe one should not take less than 5 to 6 cm. below the edge of the grossly determined lesion rather than the 2½ to 3 cm. occasionally advocated.

JOHN M. WAUGH: I think it is very significant that, if that question had been asked the panelists fifteen years ago, at least three of the four of us probably would have given an entirely different answer. It is interesting that over this period of time there has been a change of opinion in regard to the place of resection (restorative resection) for cancer of the rectosigmoid.

I happen to prefer the low anterior resection and wish to emphasize the fact that we are talking about cancer of the rectosigmoid, not cancer of the mid-rectum or even the upper rectum. This is labeled rectosigmoid. I think that one usually can get this segment of bowel below that lesion, which is important, but I emphasize that the anastomosis can be difficult, especially in the male patient, when the pelvis is small. I have wished that I had chosen Dr. Maddock's method a number of times.

One can use the pull-through operation in those situations. In other words, one may find a lesion that is high enough to satisfy the criteria for anterior resection when this may be hazardous technically. Therefore, I occasionally use the pull-through operation for a lesion in the rectosigmoidal area, especially in the male.

Even though research indicates very little longitudinal spread in the bowel wall (it is actually a matter of millimeters), one may find spread in the bowel wall. This was studied by Cole of England in about 1912. Similar studies repeated by Dr. William Black substantiated the theory of minimal longitudinal spread, but we advocated removal of a larger segment of bowel. We did find that the extent of metastasis was a matter of millimeters. From the technical standpoint I agree with Dr. Poth that one should remove as much as possible. Most of the time it is at least 5 cm. that will be removed in that area.

There is one advantage in the pull-through operation. That is, one removes more distal bowel, and that is certainly the advantage of Dr. Maddock's operation. One can remove more distal bowel and effect an anastomosis.

Do any of you routinely perform a temporary colostomy with low anastomosis? Dr. Maddock?

WALTER G. MADDOCK: While the question concerned the rectosigmoid, some of the statements I made applied to lesions of the upper rectum. Experience has taught me to perform a temporary colostomy when I perform a posterior anastomosis. A posterior anastomosis lies at the bottom of the pelvis. Fluid which collects in the abdomen drains down to this area and there is always some blood and plasma present. Shock, infection, poor healing, formation of fistulas, and gangrene were rather frequent occurrences following low operations with posterior anastomosis. For these reasons the operation became obsolete years ago.

When low anastomosis is performed, the blood supply often is inadequate in the sigmoidal, descending or splenic flexure segment

of the colon which has been brought down. It is advisable, in this case, to perform a temporary transverse colostomy to put the area at rest for a while. It is disconcerting, even in the ordinary anterior resection, to find the patient having voluminous bowel movements on the second postoperative day. I suspect that some of the preparatory castor oil occasionally is still stimulating peristalsis. This puts pressure at the site of the anastomosis and, with a tight sphincter, the sutures tend to pull apart.

The problem of the temporary transverse colostomy is when to close it. As time has gone on, I have closed them earlier. If one performs temporary colostomy and everything else looks favorable, if there has been a protected anastomosis for about three weeks and it feels satisfactory through anal digital examination, one can close the temporary transverse colostomy at approximately that time and get the patient out of the hospital in slightly less than a month.

JOHN M. WAUGH: Dr. Gerst, what is your opinion regarding temporary colostomy along with low anterior resection?

GEORGE R. GERST: As a rule, we do not use transverse colostomy. If there is any difficulty with the anastomosis or evidence of an inadequate blood supply, I think transverse colostomy should be performed. When anastomosis is extremely difficult, especially in the obese male, a pull-through operation should be performed if one has used an abdominal approach. I believe that this is indicated to reduce the danger of prolonged anesthesia, operative time and manipulation.

JOHN M. WAUGH: Dr. Poth?

EDGAR J. POTH: I do not favor an antecedent colostomy. Anastomosis frequently is executed with a single row of interrupted through-and-through sutures of No. 2–0 chromic catgut without drainage. I do not find it necessary to drain these wounds. However, I wash the wound out repeatedly and very thoroughly with a 0.5 per cent solution of neomycin. Adequate intestinal antisepsis has been used preoperatively.

If the anastomosis is low and the patient has a narrow pelvis, I think one should bring the bowel down and perform an anastomosis outside the anus. Rather than using a so-called pull-through procedure, I feel much safer when an actual definitive suture is done and the bowel replaced in the pelvis.

JOHN M. WAUGH: I believe that there is little need for a simultaneous colostomy, at least when low anterior resection from within the abdomen is performed and we can prepare the bowel well. However, I agree with the other panelists that a simultaneous colostomy should be performed if there is any question about the adequacy of that anastomosis. I use this method in about one of twenty cases.

Dr. Poth has been interested in bowel separation for years and did some of the pioneer work in this field. What method does the panel use for sterilization of the bowel? Dr. Poth?

EDGAR J. POTH: Adequate preparation of the bowel is about the same at the present time as it has been for the past ten years. Neomycin and sulfathalidine are used. In my opinion, the patients can be divided into three groups. In the first group there is no obstruction. This group can be prepared rapidly in the course of twenty hours by the administration of castor oil since there is no contraindication to purgation. Neomycin and sulfathalidine are given simultaneously every hour for four hours. The third bowel movement will contain practically no organisms. These medications should be continued every four hours until the operation is performed. The bowel will be empty and in excellent condition.

In the second group there has been obstruction but it has been resolved on suction. Although many of these patients would tolerate purgation, one should not risk it. The usual methods of mechanical preparation are instituted and neomycin and sulfathalidine are given every four hours as soon as oral intake is resumed. Upon mechanical preparation, bacteriologic preparation will be complete.

The third group does not apply particularly to this discussion. Preoperative preparation other than resuscitation is contraindicated in acute abdominal conditions. If the abdominal cavity is contaminated by any cause during exploration, it is washed with unlimited amounts of 0.25 or 0.5 per cent neomycin solutions. The solution is not left in the abdomen. There is some danger of respiratory embarrassment, but little difficulty is encountered if care is taken by the surgeon and by the anesthesist not to use excessive amounts of muscle relaxants. In fact, we have observed essentially none.

JOHN M. WAUGH: Dr. Gerst?

GEORGE R. GERST: I have very little to add to what has been said.

JOHN M. WAUGH: Dr. Maddock?

WALTER G. MADDOCK: I use approximately the same preparation, except in the first division. These patients are usually in the hospital for two or three days before operation while studies are done. I often start the administration of sulfathalidine or sulfasuxidine two days before the operation. Otherwise, I follow the same method Dr. Poth has mentioned.

JOHN M. WAUGH: Dr. Poth, do you observe staphylococcal enteritis with this preparation or will it obviate this difficulty?

EDGAR J. POTH: Staphylococcal enteritis has not occurred in our series of several thousand patients who received intestinal antiseptics. The only intestinal antiseptics that I have used have been sulfasuxidine or sulfathalidine and the combination of neomycin and sulfathalidine. Sulfathalidine used alone is not a suitable intestinal antiseptic because it causes a tenacious, ropy stool. When it is used in conjunction with neomycin, which tends to make the stool soft, sulfathalidine is perfectly satisfactory and only has to be given at half the dosage level used in the administration of sulfasuxidine.

I have not had experience with staphylococcal enteritis because I have not seen a single instance in conjunction with intestinal antisepsis.

JOHN M. WAUGH: Have any of the other panelists seen staphylococcal enteritis following colon resections in patients that have been prepared with antibiotics?

GEORGE R. GERST: I cannot provide statistics, but we have observed staphylococcal enteritis. The recent use of broad-spectrum antibiotics of any variety, from what I can determine in the region of New York, is not uncommon. Staphylococcal enteritis does occur and it is a real problem.

JOHN M. WAUGH: Dr. Maddock?

WALTER G. MADDOCK: My impression is that staphylococcal enteritis occurs when antibiotics have been used postoperatively or preoperatively for too long a period of time (seven to eleven days). There is no difficulty in the administration of antibiotics for short-term preparation as presented by Dr. Poth. Our antibiotic orders now are good for only three days and must be renewed if longer treatment is desired.

JOHN M. WAUGH: I have seen two instances of staphylococcal enteritis in patients who did not receive any intestinal antiseptics. They were given tetracycline drugs, and I think these are probably the greatest offenders of the series of drugs available to us at the present time. Are there any questions from the floor relative to the preparation of the bowel? If not, we will proceed with the next question. What is the morbidity and mortality in the various surgical procedures which you favor in the treatment of cancer of the rectosigmoid? Anterior resection produces a mortality about 1 per cent higher than a Miles operation under the same circumstances. I think that elderly patients probably tolerate low anterior resection better than a Miles operation, even though an anastomosis is present.

The mortality usually is similar, or possibly a little less, in the pull-through procedures. The morbidity, however, from certain types of the pull-through operations, is greater because there is a granulating surface. If you make a suture anastomosis as Dr. Gerst has suggested, it is probably less. However, I am impressed by the increased morbidity in the pull-through procedure if one uses the endorectal technic that Dr. Black has suggested in contradistinction to removing all the anus and rectum and leaving only the external sphincter. That will become adherent to the sigmoid much more quickly and heal more quickly, but the ultimate control is not as good as it is when a segment of lower rectum is attached to the entire anus. Added morbidity may outweigh the advantages of slightly better control.

What degree of rectal continence can one expect after these procedures? Since Dr. Maddock has mentioned the low anterior resection performed with a combined approach and the anastomosis made posteriorly, we will ask him to discuss the chances for normal control after this procedure.

WALTER G. MADDOCK: In my experience, these patients have just as great a degree of anal control postoperatively as they had before operation. As you know, that control varies in normal individuals. When an inch and a half or more of low rectum is left in place, these patients have what I would class as good to superior control. They never need to wear a napkin.

JOHN M. WAUGH: Dr. Gerst?

GEORGE R. GERST: In the classical anterior resection performed abdominally, the anal

control is as good as it was before. I think there is a difference, however, in the control of those patients who are subjected to a pull-through procedure—when a direct anastomosis is performed as compared to the group of patients in whom a segment is pulled through the anus and direct anastomosis is not performed. In my opinion, rectal control will probably return in two to three months or less if a direct anastomosis is performed outside the anus. In procedures in which there is no direct anastomosis, it is six months to a year before control returns, and there is much more stenosis requiring more frequent dilatation. As this segment of bowel that proceeds into the remaining portion of the rectal ampulla retracts and contracts, there is always the question of whether this is a malignant process.

JOHN M. WAUGH: Dr. Poth?

EDGAR J. POTH: I believe that the essential in maintaining continence is that at least 4 cm. of the distal mucous membrane and submucosa are intact. Otherwise, there is nothing that I wish to emphasize or add.

JOHN M. WAUGH: It has been my experience with anterior resection that such patients have an equal degree of control postoperatively as they had previously. Years ago Dr. Buie told me, when asked why some patients had perfectly normal control and a few did not, that many people do not have normal control before an operation. If one questioned people, I believe that one would find a great number of older people who do not have perfect control.

A suture anastomosis similar to the Swenson procedure is certainly going to result in less inflammatory reaction, but there may be a greater chance of dissemination and seeding of cells. When the entire anus is removed and only the external sphincter is preserved, the control will not be exactly normal. However, I have found that 50 per cent of these patients do not have to wear a pad. About 25 per cent of the remaining half who wear a pad have not soiled themselves. The remaining 25 per cent, for the most part, will use an irrigation and manage it as one might manage a colostomy. It is more convenient to use an enema or irrigations with the stoma in the perineum rather than the abdomen.

We have brought up the matter of five-year survival, but there does not appear to be any statistically significant difference in comparable series. Are there questions from the floor?

QUESTION FROM THE FLOOR: Do you have any information on the morbidity and mortality among patients who have some sort of restorative procedure when there is a recurrence which is treated by a Miles operation?

JOHN M. WAUGH: First, I think it is important to emphasize how many of those actually can have a second curative procedure. Of those who can have, for example, the Miles operation as a second curative procedure, what percentage can you expect to cure. Dr. Maddock?

WALTER G. MADDOCK: My experience with the second operation has been very bad in these cases. The recurrence is frequently metastasis to the liver rather than difficulty in the pelvis. The one or two that had recurrence at the low suture line, or widespread involvement, underwent further resection and a permanent colostomy. However, the patient's condition was improved for only a few months and distal metastases were almost invariably present.

GEORGE R. GERST: I have had similar experience.

EDGAR J. POTH: I believe that one point of great interest previously expressed today and for some years is whether something should be done to try to prevent the local implantation of malignant cells. At the present time the malignant lesion is isolated as soon as possible, and the bowel proximal and distal to this area is bathed for a minimum of thirty minutes with half-strength Dakin's solution or half-strength Dakin's solution adjusted to pH 9.

JOHN M. WAUGH: I cannot provide reliable statistics on secondary operations, because we have not observed enough instances. In 1944 when I started to do the type of pull-through operation that I now prefer, I re-explored every patient who came back with a local recurrence if I was unable to demonstrate distant metastasis. None of these patients had a recurrence below the levator muscle or in the vicinity of the levator muscle or sphincter without widespread involvement in the pelvis. In other words, it appeared that it was an extrinsic recurrence, that we had broken into involved lymphatics at the time of the original procedure and seeded it.

That was very similar to the experience of Miles' in his original work. We know that there were actually no nodes in the region of the posterior wound in a Miles operation. Yet, you have all seen recurrences in that scar. I believe that those recurrences result from seeding.

Unfortunately, we cannot avoid this sometimes. We break into involved lymphatics and seed them in the wound. Because there are no lymph nodes in that particular area, one cannot explain it on the basis of lymph node involvement. After observing this in twelve or fifteen patients, I decided to explore only the patients with anterior resections. If I saw what we thought was an actual suture line recurrence without anything else, we performed a Miles operation. I can remember only one patient in whom I really believed that I had accomplished anything by that secondary Miles operation.

Dr. Eric Lofgren reviewed all the anterior resections that we had performed in patients who had a recurrence in the area. This research was stimulated by the work of Dr. Cole and his associates on suture line recurrence. We found that one can accomplish a lot if it is interluminal. Fourteen or fifteen that were treated by fulguration and radium locally produced better results than a Miles operation. I think that we happened to perform the Miles procedure on patients with extensive lesions. We believed that it was only a local recurrence in the others and, fortunately, it proved to be so. I do not mean by that that fulguration and radium invariably would be more effective than a Miles operation. If it is an actual suture line recurrence, one sometimes can treat it successfully. We have treated three or four such patients who have lived more than five years after fulguration of the suture line and radium.

But, as a general rule, I agree with Dr. Maddock that these patients usually have widespread recurrence in the pelvis rather than an interluminal or bowel recurrence.

We have mentioned the difference in performing a low anterior resection in the female and the male patient. It has been pointed out that the pull-through operation might be the treatment of choice for a villous adenoma. I happen to prefer it because I treated one patient who was referred to me after extensive fulguration of a villous adenoma. The disease had been cured, but the rectum was so rigid that this patient bled with every bowel movement and bled excessively. We finally performed a pull-through procedure to remove this rectal segment. There was no recurrence of the villous adenoma in that segment and there was no carcinoma. The results were good, and the patient is happy with it. Those of you who use extensive fulgurations may have had similar experiences. Are there any other questions relevant to restorative procedures in rectosigmoidal cancer? If not, our discussion is closed.

Intestinal Malrotation in Infancy and Childhood

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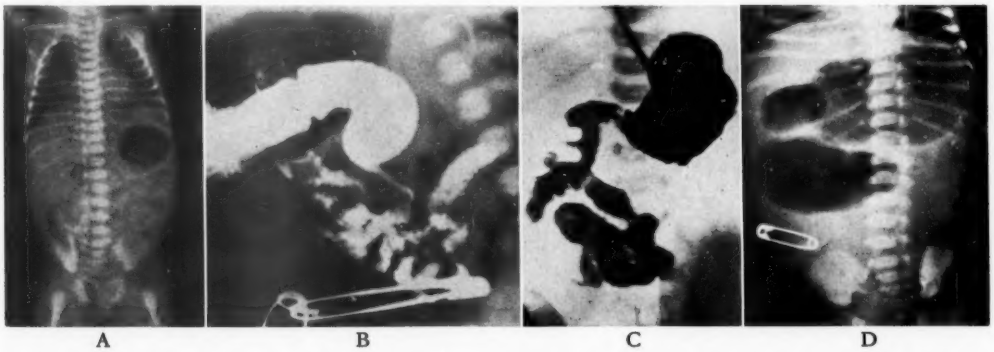
EIGHT patients with malrotation of the midgut were treated at the Medical College of Virginia Hospitals from 1953 through 1958. (Table I.) The fundamental problems in these patients were extrinsic duodenal compression and volvulus.

There was an equal incidence between sexes, although a predominance of males is found in larger series [7]. Five of the patients were newborns, two were diagnosed during the fifth and ninth weeks of life and one at the age of five years.

The history was characterized by vomiting (usually bile stained) and scanty or bloody stools. Rectal bleeding was a morbid finding in the three patients in which it occurred. Physical examination was noncontributory in three patients. Left to right epigastric peristalsis and distention were described in four instances and a pyloric tumor was palpated in one patient.

Roentgenographic studies were obtained after a history and physical examination revealed the possibility of malrotation. In every instance roentgenograms in flat and upright positions with and without contrast media were helpful diagnostically. Figure 1A is the flat film of the abdomen in a seven day old female patient (3 lb. 13 oz.) with persistent bile-stained vomiting. (Case 1, Table I.) There appears to be an excess of air in the stomach compared to the remainder of the intestinal tract. In Figure 1B, a thin barium swallow delineates narrowing in the second part of the duodenum and Figure 1C demonstrates patency after surgical therapy for malrotation with extrinsic duodenal compression.



A B C D

FIG. 1. A, flat plate of the abdomen in a newborn demonstrating some gastric dilatation; B, same patient with narrowing of the second and third parts of the duodenum; C, postoperative barium swallow demonstrating duodenal patency; and D, flat abdominal film of a newborn male with gastroduodenal dilatation.

TABLE I

SUMMARY OF EIGHT CASES OF INTESTINAL MALROTATION

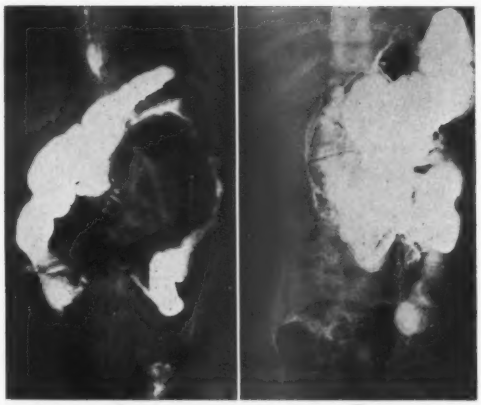
Case No.	Sex, Age Race, Weight	History	Physical Examination	X-ray Findings	Operative Findings	Results
I	F, 7 days W, 3 lb. 3 oz.	Bile-stained vomiting; scanty stools	Normal findings	Incomplete duodenal obstruction	Malrotation with extrinsic duodenal obstruction	Alive (Ladd operation)
II	M, 38 days W, 6 lb.	Projectile bile-stained vomiting; scanty stools	Pyloric "olive"	Partial pyloric obstruction; incomplete duodenal obstruction	Malrotation with extrinsic duodenal obstruction and pyloric stenosis	Alive (Ladd operation plus pyloromyotomy)
III	F, 5 yrs. N, 38 lb.	Chronic crampy abdominal pain; bile-stained vomiting	Normal findings	Incomplete duodenal obstruction; left sided cecum and colon	Malrotation with extrinsic doudenal obstruction	Alive (Ladd operation)
IV	M, 4 days W, 5 lb. 10 oz.	Vomiting not bile-stained; cyanosis; scanty stools	Adbominal distention	Complete duodenal obstruction	Malrotation with duodenal obstruction from extrinsic bands and annular pancreas at ampulla of Vater	Died seven days after Ladd operation and duodeno-duodenostomy; coarctation of aorta, intra-atrial septal defect, duodenal atresia
V	M, 3 days N, 5 lb. 9 oz.	Bloody stools; bile-stained vomiting	Normal findings	Incomplete duodenal obstruction	Malrotation with 360° volvulus; adhesions; kinking of first part of jejunum	Died eight days after Ladd operation and reduction of volvulus from obstruction of first part of jejunum
VI	F, 4 days N, 2 lb. 15 oz.	Bile-stained vomiting; scanty stools; jaundice	Peristalsis seen	Complete duodenal obstruction	Malrotation with extrinsic duodenal obstruction; volvulus; jejunal atresia	Died five days afte Ladd operation, reduction of volvulus and side to side jejuno-jejunostomy
VII	M, 65 days N, 7 lb. 12 oz.	Bile-stained vomiting; bloody stools; diarrhea	Abdominal distention	Incomplete duodenal obstruction; abdominal mass	Volvulus of midgut with jejunal perforation and abscess	Died four days after reduction of volvulus, resection and anastomosis, and drainage of abscess
VIII	F, 8 days N, 4 lb. 10 oz.	Bile-stained vomiting; bloody stools	Abdominal distention	Complete duodenal obstruction	Malrotation with volvulus and gangrene	Died eight days after reduction of volvulus, resection and exteriorization

Figure 1D is the flat film of the abdomen in a newborn Negro male with tremendous dilatation of the stomach and duodenum and a few scattered air bubbles lower down (Case V). Studies with contrast medium were unnecessary and exploration was performed for malrotation with duodenal compression and volvulus.

Figure 2A shows the results of a barium enema after a lipiodol swallow in a nine week old Negro male with bile-stained vomiting and melena of seven days duration (Case VII). There is a space filling lesion in the left upper quadrant with compression of the greater curvature of the stomach, transverse colon and splenic flexure. This lesion was a volvulus of the small bowel with jejunal perforation and abscess.

Figure 2B is the barium enema in a five year old child with intermittent abdominal pain and vomiting for four years (Case III). The cecum is in the left mid-abdomen. An upper gastrointestinal series demonstrated duodenal narrowing with proximal distention. Operation confirmed the presence of malrotation with extrinsic duodenal bands.

Surgical correction for symptomatic malrotation and volvulus is most easily performed through a long right paramedian incision through which the deformity can be visualized in its entirety [*5,6,12*]. (Fig. 3.) The tissue in the Babcock clamp in Figure 4 is the fibrous band which compresses and obstructs the duodenum as it courses between an epigastric cecum and appendix and the region of the right kidney. Division of this avascular band and mobilization of the cecum to the left abdomen



A B

FIG. 2. A, nine week old male with a barium enema roentgenogram following a lipiodol swallow; there is a space filling lesion in the left upper quadrant. B, barium enema in a five year old child which shows the cecum in the left midabdomen.

is the basis of the specific operation (the Ladd procedure) for this anomaly [8,9]. The appendix was not removed in this case, but the parents were informed of its peculiar location.

There is a clockwise volvulus of the midgut around the superior mesenteric artery in about half the patients with malrotation [1–3]. (Fig. 5.) This confusing intraperitoneal picture can be simplified by exteriorization of the entire mass in the small bowel and insertion of the hand beneath the transverse mesocolon in the region of the superior mesenteric axis [6,12].

FIG. 4. The tissue in the Babcock clamp is the fibrous band compressing the duodenum (1 = appendix; 2 = cecum; 3 = duodenum; 4 = gallbladder).

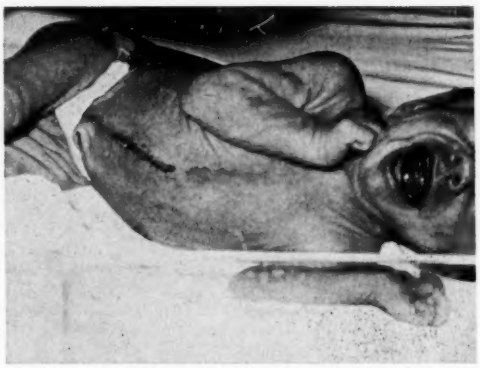


FIG. 3. Right paramedian incision utilized for the operative relief of malrotation.

The volvulus is untwisted in a counterclockwise manner, and the second and third parts of the duodenum are inspected for extrinsic bands. After these are divided the cecum and colon fall toward the left side of the abdomen and the small bowel to the right. (Fig. 6.) The duodenum should run vertically into the jejunum along the right abdominal gutter.

There were five deaths and three survivors in our series. Four patients had malrotation with duodenal compression without midgut volvulus. Three of the four are living following the Ladd procedure, including one with pyloric stenosis. In the patient with malrotation and duodenal compression who died, the operation also revealed an annular pancreas for which duodenojejunostomy was performed. Autopsy revealed severe cardiac abnormalities as well as duodenal atresia beneath the annular pancreas. This finding focuses attention on the absolute necessity of determining duodenal patency after division of the bands and mobilization of the cecum. If there is any difficulty in this

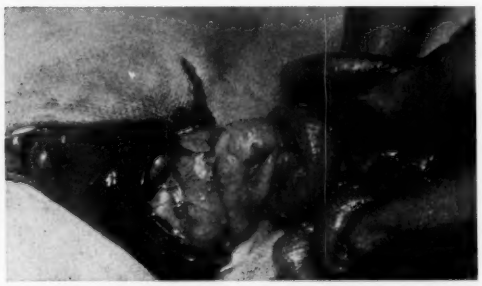


FIG. 5. Clockwise volvulus of the midgut around the superior mesenteric axis.

FIG. 6. After counterclockwise rotation of the volvulus and division of extrinsic duodenal bands, the cecum and colon are on the left of the midline and the small bowel is on the right (1 = small intestine; 2 = cecum; 3 = gallbladder; 4 = stomach).

regard, the nasogastric tube should be passed through the duodenum [4]. However, this maneuver cannot be accomplished at times. If the presence of a continuous lumen is still doubtful, the duodenum must be opened and the matter determined prior to abdominal closure [10].

In malrotation with duodenal compression and volvulus, there are no survivors and two deaths. In one, reduction of the volvulus and the Ladd procedure was followed by high jejunal obstruction from congenital bands between jejunum and transverse mesocolon. Mobilization of the duodenojejunal junction and upper jejunum into a more vertical and less tortuous plane has been suggested by Snyder and Chaffin to avoid this complication [11]. The second death in this group occurred in a premature baby (2 lb. 15 oz.) in whom an enteroenterostomy was performed for the additional anomaly of jejunal atresia.

In malrotation with volvulus without duodenal compression there were no survivors and two deaths. In one, the volvulus was complicated by jejunal perforation and in the second by gangrene of massive amounts of small bowel.

The mortality among patients with duodenal compression without volvulus is small. The high mortality with volvulus is disturbing and correlates rather well with intestinal integrity. Earlier diagnosis and operation in the presence of bile-stained vomiting and rectal bleeding would be helpful in lowering this mortality.

SUMMARY

The history, physical examination, x-ray and operative findings and surgical procedures in eight patients with midgut malrotation producing extrinsic duodenal compression and volvulus are reviewed.

Duodenal compression without volvulus is associated with a small mortality. Deaths from volvulus with bowel perforation may be prevented by prompt diagnosis and prompt operation.

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Intussusception in Adults

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INTUSSUSCEPTION of the intestine is rare in adults. Therefore, the surgeon must rely on the compilation of several isolated case reports if he is to attain some knowledge of the frequency of occurrence and the unusual features of the disease.

During the years 1954 to 1959, there were 83,661 adult admissions to Mount Carmel Hospital in Columbus, Ohio. There were four cases of adult intussusception in this group. We have reviewed three of them. The incidence we have found is similar to that reported by Donhauser and Kelly [4]. Among the 242,829 patients admitted at the Albany Hospital in New York during the years 1927 to 1947, there were twelve cases of intussusception in patients who were fifteen years of age or older.

CLASSIFICATION

Intussusception may be described as the invagination of a segment of the gastrointestinal tract into an adjacent portion. The proximal segment usually invaginates into a distal portion; however, a retrograde type occasionally may occur. An intussusception is primary (idiopathic) if no initiating pathology is found and secondary if an explanatory lesion is disclosed. A compound intussusception is one in which there are more than the usual three cylinders of a simple intussusception. Stomal intussusceptions occur as a complication of previous operative procedures such as gastrojejunostomy, colostomy and ileostomy. The different types of intussusception can be divided into two main groups—enteric and colic. These can be subdivided into four subtypes. (Fig. 1.) They are ileocolic, ileocecal, colic and enteric. Ileocolic is considered to be of the enteric type, while ileocecal is of the colic type. In the ileocecal intussusception, the head of the cecum forms the head of the intussusceptum. As pointed out by Brayton and Norris [2] it is important to differentiate, in adults, between the ileocecal and the ileocolic types since the causative lesion in ileocolic intussusception is enteric and statistically much less likely to be malignant than the ileocecal type in which the lesion originates from the cecum.

LOCATION AND OCCURRENCE

Intussusception may occur anywhere in the gastrointestinal tract below the gastric cardia. The relative frequency of occurrence of intussusception at the various sites in 748 cases (four of which were multiple) is shown in Figure 2. This includes 665 cases reported by Donhauser and Kelly [4], 80 cases reported by Brayton and Norris [2], and the 3 cases reported herein. Gastrogastric and gastroduodenal intussusceptions represented 6 per cent of this series, enteric 40 per cent, ileocolic 13 per cent, ileocecal 16 per cent, appendicocecal 4 per cent, colocolic 17 per cent and stomal 4 per cent.

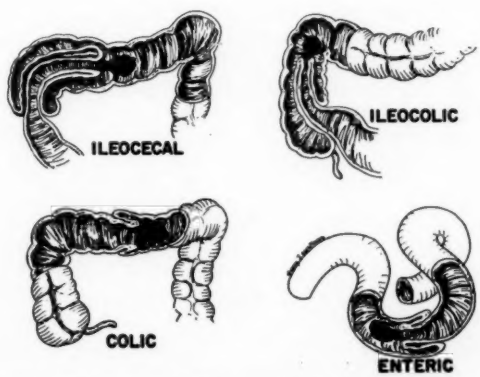

FIG. 1. Types of intussusception in adults.

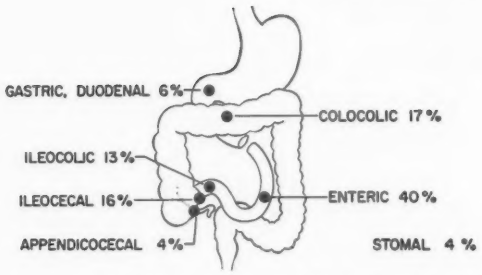

FIG. 2. Sites of intussusception in adults.

TABLE 1
SITES OF MALIGNANT AND BENIGN TUMORS RESPONSIBLE FOR INTUSSUSCEPTION (413 CASES)*

Site	Malignant		Benign		Caused by Tumor	
	(No.)	(%)	(No.)	(%)	(No.)	(%)
Gastric, duodenal...	3	15	18	85	6	21
Enteric.....	62	28	163	72	54	225
Colic.....	107	64	60	36	40	167
Total.....	172	41	241	59	413	100

* Modified from Roper [10].

ETIOLOGY

Of all intussusceptions, 5 to 7 per cent occur in adults [3,7,8,11]. The intussusceptions that occur in infants and children are predominately primary with no demonstrable cause (90 to 95 per cent). In adults 80 per cent or more of the cases of intussusceptions are of a secondary nature, because they have a demonstrable cause.

The causes of intussusception in the adult are many and varied. However, the vast majority (approximately 55 per cent) are initiated by tumors. The etiologic factors in order of decreasing incidence are: benign tumors, malignant tumors, primary (idiopathic), Meckel's diverticulum, stomal, prolapse of gastric mucosa, chronic ulcerations in typhoid fever and tuberculosis, adhesions, aberrant pancreas [1], trauma, foreign body (including Miller-Abbott tube), and miscellaneous (including visceral purpura and mobile cecum).

As previously stated, approximately 55 per cent of all intussusceptions are caused by tumors. It is also true that tumors are the etiologic factor in 6 per cent of the intussusceptions involving the gastroduodenal segment, 54 per cent of the enteric area and in 40 per cent of those affecting the colon. (Table 1.) The incidence of malignancy of tumors in these regions was 15 per cent for the gastroduodenal segment, 28 per cent for the small bowel portion, and in 64 per cent of those in the colonic areas.

The mechanism involved in the production of an intussusception of the idiopathic or primary type is postulated as being a proximal wave of contraction adjacent to a distal segment of relaxation. In a secondary intussusception a lesion apparently is responsible for starting an invagination by acting as a focus of stimulation of muscular contraction causing an increased peristalsis of the intestine and, thus, telescoping invagination of one segment into an adjacent portion. The lumen of the invaginated bowel (intussusceptum) is narrowed but rarely completely obstructed [12]. The mesentery and walls of the intussusceptum become compressed and edematous and further aggravation of the degree of obstruction ensues. Acute intussusceptions rapidly tend to become irreducible due to these changes and ulceration, and gangrene and perforation of the intussusception may occur.

CASE REPORTS

CASE 1. F. W., a forty-eight year old pharmacist, was admitted to Mount Carmel Hospital on July 29, 1959. Approximately eight hours previously he experienced acute onset of severe periumbilical pain which was accompanied by nausea, vomiting and moderate abdominal distention. His symptoms persisted and were progressive at the time of admission.

Similar episodes of abdominal pain with nausea and vomiting which terminated spontaneously and were less severe had occurred in February and again in June of 1959. There had been no hematemesis or melena. He had been given antacids and antispasmodics for peptic ulcer, which had not been documented by prior X-ray examination. He had undergone no previous surgery.

On admission there was localized distention of the left upper quadrant with tenderness over the area of distention and rebound tenderness. The abdomen was soft in the other quadrants and there was no guarding. Bowel sounds were absent except for high-pitched sounds over the area of distention.

Supine and upright X-ray films of the abdomen disclosed dilatation of small bowel loops in the upper abdomen. The chest film was not remarkable.

Admission laboratory tests revealed that the hemoglobin was 14 gm. per cent, hematocrit was 43 per cent, the leukocyte count was 11,200 per cu. mm. with 2 per cent nonsegmented neutrophils, 82 per cent segmented neutrophils, and 16 per cent lymphocytes. The serum amylase, serum electrolytes, prothrombin time, blood urea nitrogen and urinalysis were within normal limits.

The admission diagnosis was mechanical obstruction of the small bowel. An exploratory abdominal laparotomy was performed twelve hours after admission. The abdomen was opened through a right paramedian rectus incision immediately revealing a greatly dilated loop of small bowel approximately fourteen inches in length which was approximately three feet proximal to the ileocecal valve. An enteric intussusception was found and reduced manually. Following reduction, it was found that the leading point of the intussusception was a mass extending from the serosa of the bowel which was continuous with a polypoid intraluminal mass. There was no compromise of the circulation. However, the mesentery was ligated segmentally. The bowel was transected proximal and distal to the tumor which was removed with the ileum anastomosed end to end.

Microscopic examination revealed a bizarre, locally invasive, non-epithelial type of tumor of the intestinal wall, probably arising from muscle. It was not encapsulated and the overlying mucosa was ulcerated.

The patient did well postoperatively and was discharged on his seventh postoperative day.

Case II. J. M., a thirty year old insurance agent, was admitted to Mount Carmel Hospital on December 7, 1956, approximately three hours following the acute onset of upper abdominal pain.

The patient had a history of proven peptic ulcer in 1947 which was treated medically with the cessation of symptoms. He had enjoyed good health from 1947 until the day of admission when his chief complaint was an epigastric, colicky pain, accompanied by nausea, vomiting and lassitude. He had a normal bowel movement the day of admission. The patient had had an appendectomy in the remote past.

On admission, the patient had a rigid abdomen with severe upper abdominal pain and tenderness in the lower abdomen as well, more marked in the right lower abdominal quadrant. No masses were palpable in the abdomen. The bowel sounds were hypoactive.

Roentgenograms of the chest as well as upright and supine films of the abdomen revealed no abnormality.

Admission laboratory work revealed that the hemoglobin was 11.7 gm. per cent, hematocrit was 40 per cent, and the leukocyte count was 17,000 with 5 per cent nonsegmented neutrophils, 49 per cent segmented neutrophils, 45 per cent lymphocytes and 1 per cent monocytes. The serum amylase was 136 Somogyi units.

The admitting diagnosis was perforated duodenal ulcer. Approximately eight hours following the onset of his symptoms, an exploratory abdominal laparotomy was performed through a right upper rectus incision. There was no free air in the peritoneal cavity, and the stomach and duodenum appeared normal. The small bowel was explored and in the left lower quadrant there was a dilated, firm loop which revealed an enteric intussusception of the proximal ileum when it was delivered from the abdomen. The circulation of the involved bowel was not seriously compromised and the intussusception which involved approximately eighteen inches of jejunum and proximal ileum was reduced. An intraluminal polyp (3 cm.) was found to be leading the intussusception. The polyp was resected in its entirety through a longitudinal enterotomy. The tumor appeared to be benign. However, a diagnosis of infiltrating mucinous adenocarcinoma was made from permanent microscopic sections. Much of the mass forming the polyp was actually tumor invading serosal fat.

The patient passed bright red blood per rectum on his first three postoperative days. His hemoglobin fell to 6.6 gm. per cent and he was transfused with 1,500 cc. of whole blood. The bleeding ceased and the patient did well.

On December 17, 1956, an upper gastrointestinal series was obtained to rule out the presence of further polyps of large or small bowel. None was found; however, the suggestion of a duodenal ulcer was seen. The patient was discharged on December 19, 1956 without further complication.

He was readmitted on January 13, 1957 and underwent a segmental resection of the ileum at the site of the previous enterotomy. No evidence of malignancy was found in the specimen. An end to end anastomosis was performed. The patient did well and was discharged on his tenth postoperative day.

Case III. L. K., a seventy-one year old man, entered Mount Carmel Hospital on June 3, 1958 with a three week history of colicky, lower abdominal pain with associated diarrhea and occasional bright red streaking in his stool. There had been a few episodes of nausea with vomiting and a weight loss of ten pounds during the same period.

On admission the patient's abdomen was slightly distended and tympanitic, but the bowel sounds were reportedly normal. There was some guarding and tenderness in the lower abdomen with a tendency to localization in the right lower quadrant. No abdominal mass was palpable.

Barium enema examination showed obstruction

FIG. 3. Barium enema (Case III) demonstrating a filling defect in the proximal transverse colon which represents the large submucosal lipoma. Note the typical "coiled spring" appearance.

of the proximal transverse colon with the appearance of intussusception. (Fig. 3.) A polyp of the distal ileum had been demonstrated three weeks prior to hospitalization by prior barium enema. Therefore, the admitting diagnosis was ileocolic intussusception.

On June 9, 1958 exploratory surgery was performed through a right midrectus incision. A huge ileocolic intussusception was encountered involving ileum, cecum and ascending colon. Because of the inflammatory changes and the inability to reduce the intussusception, a right hemicolectomy and ileo-transverse colostomy was performed. The

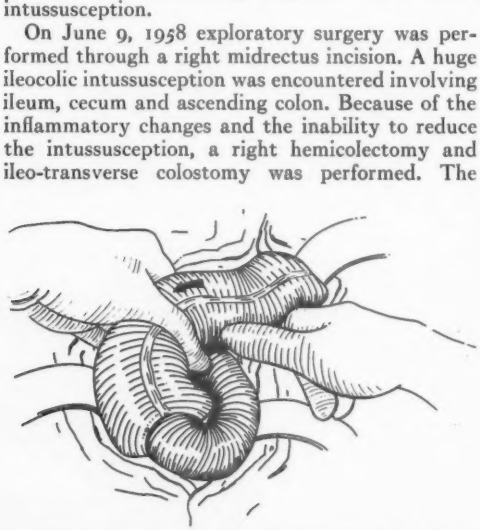

FIG. 5. Operative reduction of intussusception in adults.

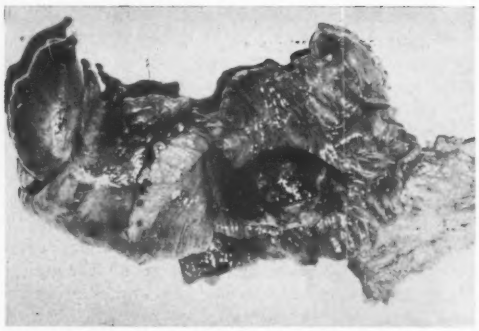

FIG. 4. The resected specimen (Case III). The transverse colon is opened over the leading point of the intussusception revealing the submucosal lipoma.

surgical specimen was opened, revealing a submucosal lipoma of the distal ileum which had led to the intussusception. (Fig. 4.)

The patient recovered from the procedure without event and was discharged on his seventh postoperative day.

DIAGNOSIS

The clinical diagnosis of intussusception is unfortunately seldom suspected and so it is missed, due to the rarity of the condition in adults. The usual history is that of a chronic recurrent partial intestinal obstruction. Intermittent abdominal colicky pain is the most common symptom. Nausea, vomiting and obstipation enter into the clinical picture as the obstruction gradually becomes complete. Blood and mucous in the stool occurs less often in adults than in infants [3,8]. In two of our three cases this symptom was absent. Palpable abdominal tumor also is an unreliable finding because it may or may not be present. This finding was absent in our three cases.

A flat film of the abdomen may show evidence of bowel obstruction by demonstrating the dilated intestinal loops. A barium enema may demonstrate the characteristic "coiled spring" appearance in cases of ileocolic or colocolic types of intussusception. This appearance is due to the passage of barium around the convex head of the intussusception with flow of barium between the folds of the mucosa of the intussuscipiens where it ensheaths the head of the intussusception. A mushroom or crescentic appearance may also be seen at the point of obstruction. These signs are usually of no value in the "enteric" cases (ileoileal, jejunoileal) of intussusception, since they are dependent en-

tirely on reflux through the ileocecal valve into the terminal ileum and only in rare instances does regurgitation of the barium enema through an incompetent ileocecal valve demonstrate the "cap" of intussusception in the terminal ileum [9].

TREATMENT

There is one important point which we would like to emphasize in connection with the treatment of intussusception in adults: there is no place for conservative treatment or attempts at hydrostatic reduction by enemas. While this method of treatment is of benefit in infants and children in which the condition almost always is primary or idiopathic, the opposite is true in adults. Benign or malignant tumors are the cause of intussusception in the majority of cases and in all three of our cases. Therefore, the removal of this causative agent is imperative. Exploratory laparotomy, usually through a right rectus type of incision, is mandatory.

The intussusception is located and manual reduction is attempted by milking out the head of the intussusception from the lumen of the intussuscipiens. Exerting traction on the proximal segment is hazardous because of the danger of causing a rent in the friable bowel wall. Illustration of the technic of manual reduction is shown below. An alternate method of reduction (described by Dr. Joel W. Baker in his discussion of the paper by Brayton and Norris [2] and ascribed to May and Normal) is introduction of a Foley catheter with the balloon collapsed, distally through the intussusception, if manual reduction is not easily performed. The balloon is then inflated, and the intussusception is more easily reduced by gentle traction with the least amount of trauma.

If reduction is obtained, the bowel is carefully inspected for possible gangrene and thoroughly searched for underlying tumor or other pathology. An exploratory enterotomy is justified after reduction in doubtful cases. Benign polyps or tumors may be removed through this enterotomy incision. In case of malignancy, resection with end to end anastomosis will be required; the extent of resection is dictated by the zone of suspected lymphatic extension.

If reduction is not possible by manipulation, resection of the intussusception is performed. The specimen is then examined carefully for underlying pathology. In cases of malignancy more radical resection may be performed and continuity established by an end to end anastomosis.

SUMMARY

1. Intussusception in adults is an uncommon condition.

2. Intraluminal tumor is the most frequent cause of intussusception in adults, with small bowel tumors more commonly producing the intussusception.

3. The majority of colon tumors producing intussusception are malignant (64 per cent as reported here).

4. In most cases the symptomatology is that of a partial recurrent intestinal obstruction.

5. The roentgenologic findings are not always contributory to the diagnosis especially in the "pure enteric" type of intussusception.

6. The treatment of adult intussusception is surgical. The frequent coexistence of underlying pathology makes surgical exploration mandatory.

7. Three cases of intussusception in adults observed during the past five years at Mount Carmel Hospital have been presented.

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Intussusception in Adults

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THE sporadic occurrence of intussusception in adults and its bizarre clinical picture account for the infrequency of a correct preoperative diagnosis. Failure to establish an early diagnosis results in a high morbidity and mortality in this condition.

Sanders [*10*] estimated that less than 10 per cent of intussusception occurs in adults and noted approximately 1,250 cases in a review of the literature published from 1892 to 1957. The addition of over fifty cases reported since the completion of Sanders' study, plus those cases from the present series brings the total reported incidence of intussusception in adults to about 1,330 cases. According to Roper [*9*], there is one adult patient admitted for intussusception every twelve to eighteen months to each one hundred surgical beds.

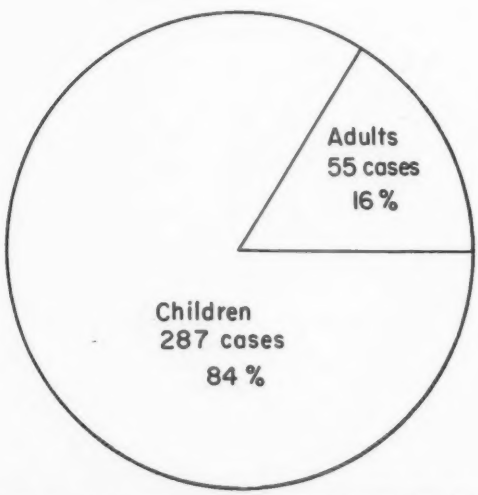

FIG. 1. Incidence of intussusception at Charity Hospital from 1904 to 1959.

The present study concerns the experience with twenty-seven episodes of intussusception in twenty-six patients over the age of thirteen years treated at Charity Hospital in New Orleans from 1938 through 1959. Intussusception secondary to colostomy or gastroenterostomy has been excluded as has intussusception not confirmed by operation or autopsy. Kahle [*8*] reported twenty-eight cases of intussusception in adults treated at this hospital from 1904 to 1938. During the fifty-five year period from 1904 to 1959, there were 287 cases of intussusception in infants and children in addition to the fifty-five examples in adults. Thus, 16 per cent of the cases of intussusception at Charity Hospital occurred in adults. (Fig. 1.)

INCIDENCE

Seasonal Incidence. Sixteen of the twenty-seven episodes of intussusception occurred between June and September. One patient operated upon for two episodes of intussusception occurring five years apart was admitted during September on each occasion. Figure 2 graphically compares the seasonal incidence in the present series with that noted in the Children's Hospital in Boston [*7*]. The increased incidence of intussusception in children during the summer months has been attributed to epidemics of diarrhea. There is no similar explanation for this seasonal occurrence in adults, however, since only four patients of the entire series complained of diarrhea. In Kahle's series from this hospital, more than half of the cases of intussusception occurred between April and August [*8*].

Age, Sex and Race. The age distribution of the twenty-seven patients is shown in Figure 3. The ratio of men to women was almost two to one. There were fourteen Negro and thirteen white patients in the series. The predominance of Negro patients admitted to Charity Hospital

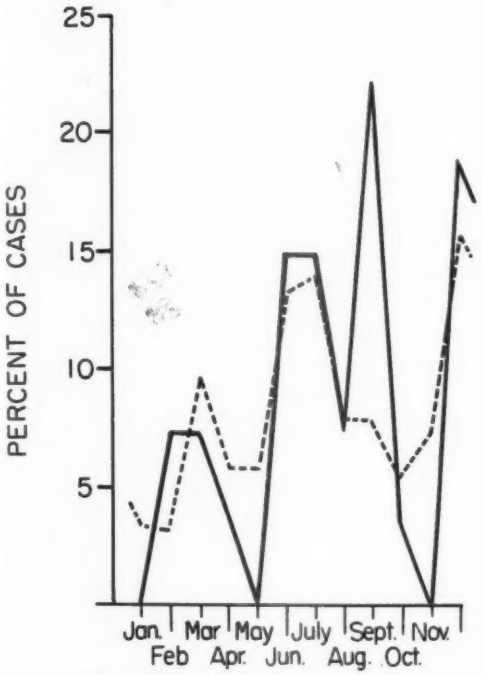

FIG. 2. The solid line represents twenty-seven adults treated at Charity Hospital. The dotted line represents a series of infants and children reported by Gross [7].

suggests the disease may be more common in the white race.

Anatomic Location. The anatomic classification of intussusception (Table I) reveals that the ileum was the most common site of involvement. The low incidence of intussusception in the colon agrees with the results of the collected series of Donhauser and Kelly [5] but

TABLE I
ANATOMIC LOCATION OF INTUSSUSCEPTION IN TWENTY-SEVEN ADULTS

Anatomic Variety	No. of Cases
Jejuno-jejunal	1
Jejuno-jejunal and ileo-ileal	1
Ileo-ileal	9
Ileo-ileo-cecal	1
Ileocecal	4
Ileo-ceco-colic	1
Ileocolic	6
Sigmoido-sigmoidal	1
Sigmoido-rectal	3

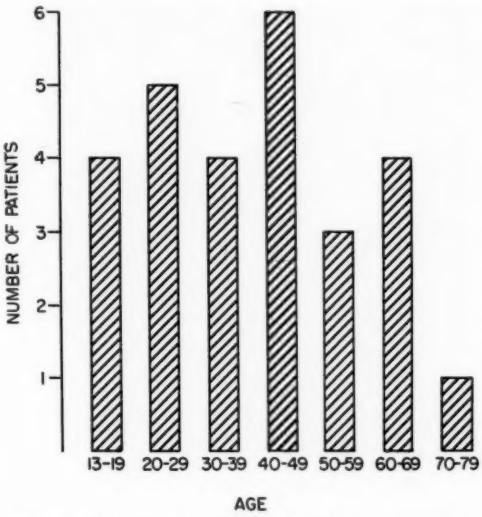

FIG. 3. Incidence of intussusception in various decades of life.

is lower than the 28 per cent reported by Sanders [10] and 60 per cent reported by Dean [3].

Etiologic Factors. Seven of the twenty-seven cases examined were of the idiopathic variety. Three of these patients complained of diarrhea, but the diarrhea was of probable etiologic significance in only one. In twenty cases a definite organic lesion was noted. Other investigators have reported a 65 to 87.5 per cent incidence of demonstrable etiologic lesions in adults in contrast to the presence of such lesions in about 5 per cent of cases reported by Gross [7] in infants and children. Benign neoplasms were found in 35 per cent and malignant tumors in 23 per cent of the present series. (Table II.)

CLINICAL FINDINGS

A correct preoperative diagnosis was made in only six of the twenty-seven patients. These six included one patient with a previous operation for intussusception, three with the lesion palpable on rectal examination and two with the typical barium enema picture of intussusception. The preoperative diagnoses in the twenty-seven patients are listed in Table III.

Frequently, the history on admission and physical findings were such that the patient was admitted to the medical, gynecologic or urologic service. The resultant delay may

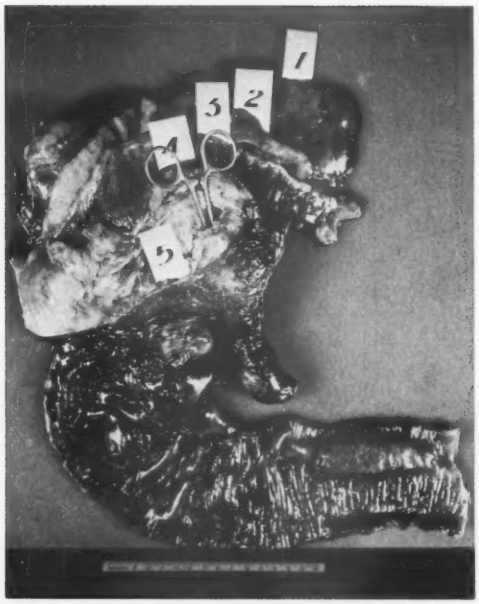

FIG. 4. Ileo-ceco-colic intussusception resected from a patient (Case 1). Forceps are within inverted Meckel's diverticulum. The five layers of the opened specimen are numbered.

account for the high incidence of gangrene revealed at operation.

CASE REPORTS

CASE 1. P. Z., a sixty-four year old white man, was admitted to the medical service on July 1, 1957 with an eight-month history of intermittent cramping epigastric pain. The pain was somewhat relieved by anticholinergics and antacids; however, multiple roentgenograms had failed to reveal ulceration in the stomach or duodenum. He had had one episode of melena during the first month of illness. The patient had vomited frequently and lost 60 pounds during the illness.

Physical examination revealed mild epigastric tenderness with pronounced borborygmi. No abdominal masses were palpated. On the fourteenth hospital day, a partial intestinal obstruction was noted.

At operation an irreducible ileo-ceco-colic intussusception was revealed which was believed to be due to carcinoma. A right hemicolectomy was performed with the removal of 100 cm. of distal small bowel.

Pathologic report revealed an ileo-ceco-colic intussusception due to an inverted Meckel's diverticulum, with gangrene of the distal 50 cm. of ileum. A peptic ulcer was present in the gastric mucosa located within the diverticulum. (Fig. 4.)

TABLE II
ETIOLOGY OF INTUSSUSCEPTION IN TWENTY-SEVEN ADULTS

Etiology	Patients	
	No.	Per cent
Benign neoplasm	9	33.3
Submucosal lipoma of jejunum	1	
Adenomatous polyp of jejunum and ileum	1	
Adenomatous polyp of ileum	3	
Hemangioma of ileum	1	
Leiomyoma of ileum	1	
Carcinoid of ileum	1	
Lipoma of ascending colon	1	
Malignant neoplasm	6	22.2
Adenocarconoma of ileum	1	
Lymphoma of ileum	1	
Carcinoma of sigmoid and recto-sigmoid colon	4	
Inflammatory process	4	14.8
Nonspecific in terminal ileum or cecum	3	
Regional ileitis	1	
Meckel's diverticulum	1	3.7
Idiopathic	7	26

TABLE III
PROVISIONAL DIAGNOSIS OF INTUSSUSCEPTION IN TWENTY-SEVEN ADULTS

Diagnosis	No. of Cases
Small bowel obstruction	5
Small bowel obstruction due to adhesions	5
Intussusception	6
Acute appendicitis	3
Ruptured appendix	3
Colon obstruction due to neoplasm	1
Ruptured ectopic pregnancy	1
Ruptured ovarian cyst	1
Volvulus of the colon	1
Renal calculus	1

CASE 11. J. M., a fifty-six year old Negro man, was admitted in April 1947 with lower abdominal cramps and bright red blood in his stool. Diagnostic examination including proctoscopy, roentgenograms of the upper gastrointestinal tract, and barium enema, was negative. After his symptoms subsided he was discharged. On December 8, 1947 he was readmitted because of severe colicky pains

with vomiting of ten weeks duration. He had been passing dark red blood rectally for two weeks prior to admission. Results of physical examination on admission included diffuse abdominal tenderness, and the absence of peristalsis. There was no rebound tenderness. On the seventh hospital day a moveable abdominal mass was noted in the left lower quadrant with signs of generalized peritonitis. Laboratory data, barium enema and results of proctoscopy were normal. Emergency operation revealed an ileo-ileal intussusception with peritonitis and gangrene. The 150 cm. of gangrenous bowel was resected and a double-barrelled ileostomy was performed. The patient died 16 hours following operation.

Pathologic report revealed that the gangrenous ileo-ileal intussusception was due to a polypoid adenocarcinoma of the ileum. There were multiple perforations of the ileum.

CASE III. E. H., a Negro woman who was twenty-five years of age, was admitted to the medical service on October 31, 1955 with epigastric pain and vomiting of six days duration. The pain was increased by eating and was more severe when the patient was in the supine position. The abdomen was soft, tender on the left, and contained a mass to the left of the umbilicus. Bowel sounds were hyperactive. Thirty-six hours after admission her symptoms increased and the surgical service was consulted. The diagnosis was "partial high intestinal obstruction."

At operation she was found to have an easily reducible ileo-ileal intussusception occurring approximately 50 cm. from the ileocecal valve. The bowel was viable and contained an intraluminal pedunculated tumor 3 cm. in diameter. The mass was resected with 8 to 10 inches of small intestine. One of numerous enlarged mesenteric lymph nodes was removed for biopsy.

Pathologic diagnosis was a pedunculated malignant lymphoma of the ileum. Malignant lymphoma was also present in the lymph node.

CASE IV. E. H. T., a fifteen year old Negro girl, was admitted to the gynecology service on September 25, 1940 in shock and semiconscious. The history obtained from the family suggested ectopic pregnancy. On physical examination, the cervix was soft and the cul-de-sac bulging. White blood count was 8,000 per cu. mm. and hemoglobin 70 per cent. Emergency laparotomy within ninety minutes following admission revealed an irreducible intussusception with 3 feet of gangrenous ileum perforated in two areas. A tube enterostomy was performed proximal to the intussusception and the gangrenous bowel was exteriorized. The patient died 8 hours after operation.

Autopsy and pathologic report revealed that there was a gangrenous ileo-ileal intussusception due to an adenomatous polyp. Three were two sites of perforation of the ileum with generalized peritonitis. Additional polyps were found in the jejunum, colon and rectum.

CASE V. E. S. P., a thirty-eight year old white woman, was admitted on February 24, 1941 with aching epigastric and suprapubic pain of four days duration. The pain was relieved by castor oil and abdominal splinting. The patient had had similar episodes intermittently for six months. The only pertinent findings on physical examination were hyperactive bowel sounds and a lower abdominal scar from a previous oophorectomy. By the fourth hospital day there were signs of a partial intestinal obstruction.

At operation, an ileo-ileal intussusception was revealed 3 feet proximal to the ileocecal valve. It was easily reduced manually, and no intraluminal masses were palpated. The postoperative course was uncomplicated.

These five cases illustrate the variety of clinical syndromes and the confusing clinical course of patients admitted to nonsurgical services and to surgical services where the proper diagnosis was not considered. A review of the history and physical findings obtained from the twenty-seven patients indicates those items which should suggest the correct diagnosis to the clinician.

In all but one case the chief complaint was abdominal pain which was usually colicky. It was located in the lower abdomen in sixteen patients, middle and upper abdomen in seven patients and throughout the abdomen in three. Thirteen patients had pain for three days or less, ten for one to two weeks, and three for two to eight months. Vomiting was present in over 75 per cent of the cases and usually was mild and of the same duration as the abdominal pain. Diarrhea was present in four cases. Constipation was infrequent, and obstipation for more than one day occurred in only four cases. Some form of rectal bleeding was present in eight patients and five of the six patients with bright red blood per rectum had an underlying carcinoma as the cause of the intussusception.

Fifteen patients had previous gastrointestinal symptoms and in six of these prior episodes of intussusception seem likely. A seventh patient with Peutz-Jeghers disease had been operated upon twice before for intussusception. Among the patients without previous gastrointestinal

symptoms were four patients with idiopathic intussusception and two with a nonspecific inflammatory process in the terminal ileum. Weight loss was reported by six patients, four of whom had benign disease. The largest amount of weight loss occurred in the patient (Case 1) with intussusception due to Meckel's diverticulum.

Findings on physical examination were similarly atypical. Only fifteen patients appeared acutely ill. Abdominal distention occurred in less than half of the cases and was usually mild. Some degree of abdominal tenderness was present in almost all patients; however, bowel sounds were considered obstructive in only one-third of the cases. Eleven patients had an abdominal mass, but in only one case was the mass described as "disappearing." Rectal examination was of positive value in those three patients with rectosigmoid carcinoma and in the patient with carcinoma of the ileum in whom dark red blood was present in the rectum. Cul-de-sac tenderness was present in seven cases.

MANAGEMENT

Laboratory Findings. Routine laboratory studies were of little value. White blood cell counts averaged between 10,000 and 11,000 per cu. mm. and were the same in those patients with intestinal gangrene and those with viable bowel. Deterling [4] reported that none of five patients with gangrenous intussusception in his series had white cell counts above 10,000 per cu. mm. In the present series, hematocrits and hemoglobin levels were usually within normal limits. Serum electrolyte values were compatible with the severity of the intestinal obstruction. Complete intestinal obstruction was rare in this series and fluid and electrolyte balance was generally good in most patients.

Roentgenographic Examination. Scout films of the abdomen established the diagnosis of intestinal obstruction in eleven patients. Barium enema revealed classic intussusception in three patients and obstruction of the colon in one. In these four cases, which did not include those with sigmoidorectal intussusception, the scout films were noncontributory. Barium enema was used in the patients with visible and palpable intussusception into the rectum as a means of determining the location of the lesion. Roentgenograms of the upper gastrointestinal tract revealed intussusception of the small bowel in one of the two patients upon whom it was used, however, the barium increased the severity of his obstruction.

Diagnosis. Review of clinical results, x-ray films, and laboratory data indicates that there is only one way to maintain a high degree of diagnostic accuracy: The possibility of this diagnosis must be kept in mind. There is no difficulty in establishing the diagnosis of a sigmoidorectal intussusception since the symptoms are readily recognized by the patient and the lesion can be demonstrated by rectal examination or proctoscopy. However, intussusception of the small bowel, ileocecal and ileocolic varieties pose major problems, particularly because of the resulting incomplete intestinal obstruction. The results of examination may not be critical enough to warrant surgery until strangulation or gangrenous obstruction has developed.

Treatment. The usual presence of an underlying organic lesion and the infrequency with which spontaneous reduction will occur, make it imperative that operation be performed as soon as the diagnosis is suspected. The 11 per cent mortality rate in the present series is too high. Two of the three deaths could have been prevented by earlier operation. One patient, a twenty-eight year old man with idiopathic ileo-ileo-cecal intussusception, died on the fifth hospital day without operation, and gangrenous intussusception was revealed at autopsy. The other, a woman with carcinoma of the small intestine, was not operated upon until the seventh hospital day and by the time of operation gangrene of the bowel with perforation and peritonitis had developed.

The difficulty in establishing a correct diagnosis was responsible for a delay of operation for three to seventeen days in ten of the twenty-seven patients. This delay was fatal in the two cases just described, and resulted in the development of gangrenous bowel in two others. The presence of intestinal gangrene in five patients operated upon within twenty hours after admission constitutes further evidence in favor of early operation.

The enteric variety of intussusception (ileo-ileal, jejuno-jejunal, and the like) may be treated simply if manual reduction is possible. The lesion is examined and removed either by enterotomy and excision if benign, or by resection of a segment of bowel and mesentery in cases of suspected malignancy. It is imperative

to examine carefully the remainder of the intestinal tract because of the high incidence of multiple polyps. If the intussusception is not reducible the involved bowel should be resected whether or not frank gangrene is present. Resection is indicated because of the high incidence of underlying organic lesions. Exteriorization procedures with ileostomy are to be avoided. The two deaths in the group which underwent operation occurred in patients having an ileostomy.

Ileocecal or ileocolic intussusception constitutes a more difficult problem. If the bowel can be easily reduced, the site of the lesion may be determined, biopsy and frozen section performed and appropriate therapy instituted. However, in the presence of an irreducible intussusception it is difficult to determine whether the lesion is located in distal ileum, cecum or proximal colon. Sanders' recommendation that no attempt at reduction be made and radical resection for malignancy be performed is based upon the high incidence of malignancy associated with intussusception of the colon [*10*]. It must be noted, however, that the two patients of the present series believed to have carcinoma and who underwent right hemicolectomy actually had a lipoma of the colon and Meckel's diverticulum, respectively.

In severely ill patients not having devitalized bowel, the terminal ileum or right colon lesion may be by-passed by an ileo-transverse colostomy and resection performed later as a second-stage procedure. This was successfully accomplished in two patients of the present series.

Intussusception due to lesions arising in the rectosigmoid and sigmoid is almost always indicative of malignancy. Since these patients have an obstruction of the left colon a defunctionalizing right transverse colostomy should be performed as a first stage procedure. The intussusception may be reduced at the first operation or may reduce spontaneously following the decrease in the inflammation and edema of the involved bowel. A curative resection can be performed later at a time of election.

Sanders' radical approach to the treatment of intussusception in the colon minimizes trauma to the lesion and may reduce the incidence of metastases when malignancy is present. The works of Cole [*1,6*] and Cohn [*2*] emphasize the adverse effects of trauma of the malignant lesion. It would seem practical, however, that if the intussusception, particularly with lesions of the right colon, is easily reducible the mass should be evaluated by palpation and frozen section when indicated, in order to spare the patient a needless extensive resection.

Reduction of intussusception by barium enema is contraindicated in adults because of the usual presence of a specific organic lesion and the high incidence of irreducibility.

The mortality rate of 11 per cent in this series of twenty-seven cases represents a significant improvement over the 42.8 per cent reported by Kahle [*8*] from 1904 to 1938. This increase in survival is attributed to earlier operation for intestinal obstruction as well as the improved treatment possible with antibiotics, modern blood bank facilities and modern methods for pre- and postoperative care.

SUMMARY

An analysis of twenty-seven episodes of intussusception in adults treated at Charity Hospital from 1938 through 1959 is presented. Ileo-ileal intussusception was the most common anatomic variety. Only 19 per cent of the cases were due to lesions of the colon. Seventy-four per cent of the patients had a specific underlying lesion as the cause of the intussusception. The lesion was malignant in 22 per cent of the cases. Operative treatment required more extensive procedures in all but four patients, when manual reduction sufficed. Gangrenous bowel in nine of the twenty-seven cases indicates the importance of early operation. In easily reducible cases of intussusception of the small bowel and right colon, an attempt may be made to determine whether the lesion is benign or malignant. If the intussusception is irreducible or difficult to reduce, an adequate operation for cancer should be performed, preferably in one stage. In patients with intussusception of the left colon, a defunctionalizing colostomy should be performed as a first-stage operation so that an adequate resection can safely be performed later.

The clinical picture and x-ray findings associated with intussusception in adults are bizarre and a correct preoperative diagnosis is rarely made. The surgeon should consider intussusception whenever he is confronted with a patient with confusing abdominal symptoms.

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Tumors of the Small Bowel

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ALTHOUGH tumors of the small bowel are uncommon, the general surgeon must consider them in all cases of unexplained abdominal pain or gastrointestinal bleeding. The literature concerning these neoplasms continues to accumulate which may indicate an increased awareness, an increased incidence, or a greater facility for the detection of these lesions. This study was undertaken to analyze the experience with tumors of the small bowel at the Geisinger Memorial Hospital, a general hospital in central Pennsylvania with a capacity of 300 beds.

MATERIAL STUDIED

A total of thirty-six cases of primary tumors of the small bowel have been treated since this hospital was opened in 1915. However, autopsy and surgical pathology records are complete only since 1925. Therefore, this study covers a period of thirty-three years (1925 to 1957). Only verified neoplasms originating in the duodenum, jejunum or ileum have been studied. (Table 1.) One case of small bowel gumma is included because of its resemblance to a true neoplasm. Neoplasms of Vater's papilla, metastatic tumors of the small bowel and such benign lesions as accessory pancreatic rests and ectopic gastric mucosa have been excluded.

INCIDENCE

The thirty-six tumors seen during this period were collected from 209,101 hospital admissions, an incidence of 0.017 per cent.

Sixteen cases were discovered in the performance of 2,928 autopsies, an incidence of 0.54 per cent. Buckstein [4] reported thirty-five benign, twenty-nine malignant and five unclassified tumors of the small bowel among 22,810 autopsies, or incidence of 0.15, 0.13 and 0.02 per cent, respectively. The total incidence was 0.3 per cent for all tumors of the small bowel. Shandalow [20] reported twenty-two benign tumors of the small intestine among 2,648 autopsies, an incidence of 0.83 per cent. Raiford [15] found that 8.9 per cent of all gastrointestinal tumors occur in the small bowel. He stated that 23.8 per cent of all

TABLE 1
TOTAL NUMBER OF SMALL BOWEL TUMORS FROM 1925 TO 1957

Type of Tumor	Number	Location		
		Duodenum	Jejunum	Ileum
Asymptomatic	18	4	4	10
Adenomatous polyp	3	0	0	3
Leiomyoma	2	0	1	1
Adenomyoma	2	2	0	0
Papilloma	2	0	0	2
Hemangioma	2	0	0	2
Carcinoids	2	0	0	2
Leiomyofibroma	1	0	1	0
Fibroma	1	1	0	0
Adenoma	1	0	1	0
Lymphangioma	1	1	0	0
Gumma	1	0	1	0
Symptomatic	18	4	4	10
Adenocarcinoma	4	0	3	1
Leiomyoma	4	2	0	2
Leiomyosarcoma	3	0	0	3
Carcinoids	2	0	0	2
Adenomatous polyp	1	1	0	0
Lipoma	1	1	0	0
Lymphosarcoma	1	0	1	0
Fibroma	1	0	0	1
Fibroadenoma	1	0	0	1
Total.....	36	8	8	20

TABLE II
SUMMARY OF PERTINENT DATA

Type of Tumor	Number	Sex		Average Age (yr.)	Average Size (cm.)	Average Duration of Symptoms (mo.)
		Male	Female			
Asymptomatic	18	14	4	56.8	0.95	...
Benign	16	12	4	56.5	0.94	...
Malignant	2	2	0	59	1.0	...
Symptomatic	18	10	8	55.9	6.2	19
Benign	8	4	4	51.9	4.0	32
Malignant	10	6	4	59.1	8.2	9.5
Total	36	24	12	56.4	3.58	...

benign and 4.9 per cent of all malignant gastrointestinal tumors occur in this area.

In our series, symptoms were produced by eighteen tumors which were diagnosed at operation or postmortem examination. The other eighteen caused no symptoms and were found incidentally at autopsy or in surgical specimens extirpated for other conditions. Each group will be discussed separately.

ASYMPTOMATIC TUMORS

Sixteen asymptomatic tumors of the small bowel were discovered at postmortem examination and two in surgical specimens. In one patient a duodenal lymphangioma was found in a surgical specimen removed for carcinoma of the head of the pancreas. The other patient had adenomatous polyps in the ileum. These were found in a surgical specimen removed for carcinoma of the colon. Sixteen of these tumors were benign, and two were carcinoids. The latter, although exhibiting no evidence of local invasion or distant metastases, must be considered potentially malignant [*15*].

Table II summarizes pertinent data about these tumors of the small bowel. Men outnumber women in most reported series [*6,13,20*], but the vast majority of men in the present study is not the usual finding. River, Silverstein and Tope [*17*] found essentially an equal distribution between the sexes in a series of 1,323 benign lesions of the small bowel.

The age range of patients in this group was thirty-two to eighty years. Small bowel tumors have been found in younger persons. In the series reported by River and his group [*17*], nineteen benign lesions were reported in infants less than one year of age. Duncan (cited by McComb and Pridgen) [*12*], reported a carcinoma in a three and a half year old child.

The anatomic distribution in this series coincides with the high number of ileal tumors found in any study of neoplasms of the small bowel. The number of tumors found in the ileum usually equals the number in the other two segments combined.

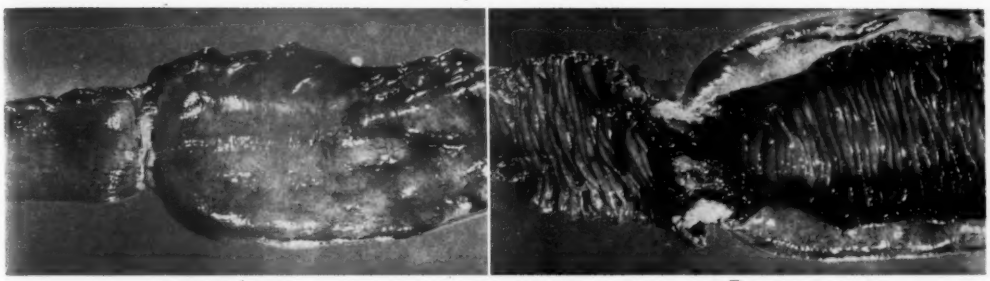
Tumors ranged from 0.2 to 2 cm. in diameter and averaged 0.95 cm.

SYMPTOMATIC TUMORS

Symptoms referable to tumors of the small bowel occurred in eighteen patients and led to operative intervention in seventeen instances. The eighteenth case was diagnosed at autopsy. Ten tumors were malignant and eight benign. All four duodenal tumors were benign and all four jejunal tumors were malignant. Among the ileal neoplasms six were malignant and four benign. Symptomatic tumors were malignant more often than they were benign [*3,6,14,18,21*].

Table II summarizes pertinent data found in studying these tumors. The sexes were almost evenly represented in this group in contrast to the predominance of men in the asymptomatic group. Age and anatomic distribution were similar to those in the asymptomatic group.

The lesions varied from 1.5 to 25 cm. in diameter. The benign tumors averaged 4 cm. and the malignant ones 8.2 cm. in diameter. The symptomatic tumors usually were considerably larger than the asymptomatic lesions. Undoubtedly this was a major factor in the production of symptoms. Although the largest asymptomatic tumor of the bowel measured



A B

FIG. 1. A, napkin-ring carcinoma of jejunum producing obstruction (bowel closed). B, napkin-ring carcinoma of jejunum producing obstruction (bowel open).

2 cm. and the smallest symptomatic neoplasm only 1.5 cm., it appears that a certain critical size was attained before symptoms referable to the tumor became manifest. The present series is too small to furnish statistically significant data, but it strongly suggests that a tumor of the small bowel which is more than 2 cm. in diameter will produce symptoms, and one smaller than 2 cm. will not.

The duration of symptoms from onset to hospital admission averaged much less for patients harboring malignant tumors than for those with benign neoplasms, indicating the more rapid growth in malignant lesions.

Symptoms. The symptoms secondary to tumors of the small bowel can be grouped into three major syndromes: bleeding, obstruction and abdominal pain. (Table III.) In this series, five presented as bleeding, seven as obstruction and four as abdominal pain. One patient complained of an asymptomatic abdominal mass (lymphosarcoma), and the last patient came to the hospital with an incarcerated left inguinal hernia containing a small bowel neoplasm (leiomyosarcoma). Incarceration of this type has been reported previously [17].

Three benign and two malignant tumors of the small intestine were responsible for the five cases presenting with bleeding. All three benign lesions were situated in the duodenum; two were leiomyomas and one was a lipoma [2]. One malignant neoplasm was located in the jejunum (adenocarcinoma) and the other in the ileum (leiomyosarcoma). Three patients had a history of melena, and two had unexplained anemia.

In this series, four patients with benign and three with malignant lesions exhibited the obstruction syndrome. Mayo [12] credits small bowel tumors with causing 1.5 per cent of all obstructions of the small intestine. According to River, Silverstein and Tope [17], the most common cause of intussusception in the adult is a benign tumor of the small bowel, and this occurred in three patients in this group. The fourth benign lesion, an adenomatous polyp of the first part of the duodenum, caused a pyloric obstruction simulating a stenosing duodenal ulcer. The three malignant tumors, all napkin-ring adenocarcinomas, manifested themselves as low grade obstructions for three and a half to five months before becoming severe enough for the patients to seek medical attention. Figure 1 is an example of an obstructing napkin-ring carcinoma. These napkin-ring lesions caused slow, progressive diminution of the lumen as opposed to the more acute nature of intussusception seen with the benign lesions.

TABLE III
MAJOR CLINICAL SYNDROMES AND SYMPTOMS AND SIGNS IN EIGHTEEN PATIENTS

Symptoms and Signs	Benign Tumors	Malignant Tumors
Major syndromes		
Bleeding	3	2
Obstruction	4	3
Abdominal pain	1	3
Other	0	2
Individual symptoms and signs		
Pain	7	9
Vomiting	4	5
Anemia	3	6
Eructation	4	4
Constipation	4	4
Weight loss	4	4
Abdominal mass	2	5
Anorexia	3	3
Diarrhea	2	3
Melena	2	3
Emaciation	2	2

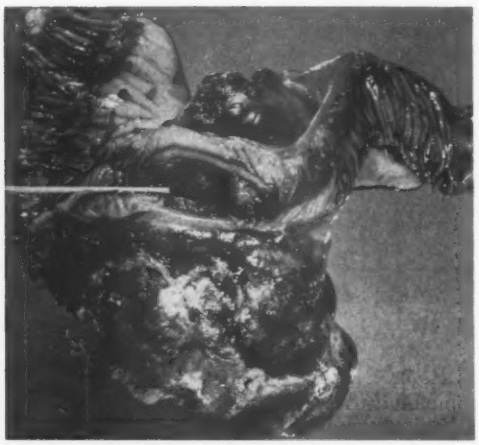


FIG. 2. Leiomyosarcoma of ileum producing ulceration of mucosa.

Pain was the only feature of four tumors, one benign and three malignant, involving the ileum. A leiomyoma produced pain in the right upper quadrant, two carcinoids caused lower abdominal pain, and epigastric pain occurred in a patient with a leiomyosarcoma. The cause of abdominal pain is obscure. Low grade or intermittent obstruction is one explanation, but evidence of proximal dilatation or hypertrophy was lacking in these patients.

All signs and symptoms elicited in the eighteen patients in this group are listed in Table III. Although abdominal pain was the only complaint in four patients, twelve other patients also had pain, thus making it the most common symptom experienced by these patients. This was variously described as crampy, sharp, aching, postprandial or continuous. The most common location of pain was the epigastrium, followed by an equal distribution among the remaining regions of the abdomen. Vomiting and anemia were present in half the cases. Anemia was two times more frequent in patients with malignant than in those with benign lesions. Weight loss, usually associated with malignancy, was as common among patients with benign as with malignant lesions. A palpable abdominal mass occurred more often in patients with malignant tumors.

Diagnosis. Roentgenographic examination is the only means available, short of surgical intervention, to make a definite diagnosis of tumors of the small bowel. Ten of sixteen patients subjected to roentgenographic studies preoperatively showed evidence of small bowel abnormality. (Table IV.)

TABLE IV
ROENTGENOGRAPHIC EVIDENCE OF SMALL BOWEL ABNORMALITY IN SIXTEEN PATIENTS

Type of Study	Number of Studies Performed	Positive Findings		Total Positive Findings
		Benign Tumors	Malignant Tumors	
Plain film of abdomen	2	1	0	1
Stomach and duodenum study	7	4	1	5
Small bowel series	4	1*	2	3
Barium enema examination	8	1*	1	2

* One case was diagnosed by small bowel series and barium enema examination.

Of two patients of whom plain films of the abdomen were taken, one was found to have a typical small bowel obstruction and the other no demonstrable abnormality. At operation the first patient was found to have a benign fibroadenoma of the ileum causing an ileoileal intussusception. The second patient had a huge leiomyosarcoma of the ileum.

Five positive results were obtained in seven roentgenographic studies of the stomach and duodenum. Four benign duodenal tumors and a napkin-ring adenocarcinoma of the jejunum were found by this study. The two patients with normal findings later proved to have a fibroma of the ileum and a fungating adenocarcinoma of the jejunum.

Roentgenographic examinations of the small bowel were performed on four patients, one with a benign and three with malignant lesions. The benign lesion, a leiomyoma of the ileum, was the leading point of an ileoileal intussusception. The two malignant tumors which were discovered by this study were both adenocarcinomas. One of these, a jejunal lesion, was a polypoid, fungating tumor 5 cm. in diameter. Seven months prior to the small bowel series a roentgenogram of the stomach and duodenum revealed no abnormalities. The other was an ileal adenocarcinoma which was napkin-ring in character and caused a partial obstruction.

TABLE V

COURSE OF PATIENTS WITH MALIGNANT TUMORS

Type of Tumor	Location	Duration of Symptoms (mo.)	Type of Treatment	Course	Total Duration of Illness (mo.)
Adenocarcinoma	Jejunum	3.5	No operation	Died during 4th week of hospitalization	4.5
Adenocarcinoma	Jejunum	5	Wide resection with corresponding mesentery	Pleural effusion developed 4 mo. postoperatively, died 7 mo. postoperatively	12
Adenocarcinoma	Jejunum	6	Biopsy; marked celiac node metastases	Died 3 mo. postoperatively	9
Adenocarcinoma	Ileum	5	Segmental resection	Discharged from hospital, lost to follow-up study	...
Leiomyosarcoma	Ileum	4	Segmental resection	Died 50 mo. postoperatively	54
Leiomyosarcoma	Ileum	7 days	Segmental resection	Living and well 25 mos. postoperatively	...
Leiomyosarcoma	Ileum	41	Wide resection with corresponding mesentery	Died 39 mo. postoperatively	80
Carcinoid	Ileum	0	None	Discovered at autospy	Asymptomatic
Carcinoid	Ileum	0	None	Discovered at autopsy	Asymptomatic
Carcinoid	Ileum	24	Excision of polypoid lesion	Living and well 30 mo. postoperatively	...
Carcinoid	Ileum	2	Wide resection with corresponding mesentery	Died 45 mo. postoperatively	47
Lymphosarcoma	Jejunum	6	Wide resection with corresponding mesentery; all involved nodes not removed	Died 5 mo. postoperatively	11

A leiomyosarcoma of the ileum measuring 12 cm. that had grown extraluminally was not discovered although it had produced ulceration of the mucosa. (Fig. 2.)

Eight barium enema examinations were performed on patients in this series. Two indicated small bowel abnormalities. One showed a filling defect in the terminal ileum caused by an ileoileal intussusception. This was also seen in a small bowel series as mentioned in the preceding paragraph. The second revealed normal findings in the colon, but a proximal obstruction of the small bowel was noted. This later was found to be a napkin-ring carcinoma of the jejunum. One jejunal and five ileal tumors were not noted when the colon was studied.

The x-ray studies with the highest yield of positive results were those of the stomach and duodenum and the small bowel series. The duodenum is the easiest portion of the small bowel to examine due mainly to its fixed position. The jejunoileal segment of the small bowel does not lend itself as well to x-ray examination. Three methods for examination of this area have been suggested. Abbott and Johnston [*1*] and Schatzki [*19*] utilized nasogastric tubes to introduce barium contrast media into the small intestine. A third method, the "motility series," is used in our hospital to study this part of the gastrointestinal tract. A barium sulfate solution is ingested and its progress through the small bowel is followed roentgenographically at one-half to one hour intervals.

The presenting symptoms and signs should determine the type of roentgenologic examination necessary for diagnosis. In suspected intestinal obstruction, a plain film of the abdomen is advisable before proceeding with contrast studies. When indeterminate abdominal pain and/or gastrointestinal bleeding are involved, studies of the stomach and duodenum should be made to rule out lesions in these areas. It is necessary to procede with

a study of the small bowel only when the plain film and studies of the stomach and duodenum demonstrate no abnormalities

If all x-ray studies are negative and persistent symptoms indicate small bowel involvement, exploratory laparotomy becomes mandatory. In the present group of eighteen symptomatic tumors of the small bowel only ten were found preoperatively by means of roentgenography. In the other eight the following indications for operation existed: recurrent melena, intermittent intestinal obstruction, incarcerated inguinal hernia, nonvisualized gallbladder, filling defect in the cecum on barium enema examination, and a palpable abdominal or pelvic mass in three cases.

TREATMENT AND PROGNOSIS

Discovery of a tumor of the small bowel either benign or malignant, is the indication for treatment. This consists of primary excision of benign lesions and resection of the involved bowel with its adjoining mesentery for malignant tumors. Excision or segmental resection of benign tumors is curative. Although none were encountered in this study, multiple benign tumors of the small bowel have been reported, and repeated operations were necessary [*17*]. Table v summarizes the results of treatment in twelve patients with malignant tumors. Two patients appear to be free of disease for twenty-five and thirty months following treatment. Both of these cases were rather unusual. One patient was a sixty-three year old man admitted to the hospital for treatment of an incarcerated left inguinal hernia. At operation, a leiomyosarcomatous lesion of the ileum was found within the hernial sac. This was resected with the adjacent normal ileum and primary anastomosis performed. The second was a fifty-five year old man who had experienced abdominal pain for two years and had a nonvisualized gallbladder on x-ray examination. At operation a carcinoid tumor measuring 1.5 cm. was found in the ileum and excised.

One patient, a seventy-two year old woman with adenocarcinoma of the jejunum for whom primary resection with end-to-end anastomosis was performed, was lost to follow-up study.

Adenocarcinoma of the small bowel is the most lethal malignancy of this segment of the gastrointestinal tract. Three patients with this lesion died within twelve months after onset of symptoms.

Although leiomyosarcomas produced fatal outcomes in two of three patients, the patients survived for a longer time. One patient survived fifty-four months and the other eighty months after the onset of symptoms. In view of the prolonged course of leiomyosarcomas, it is obviously too soon to consider the third patient, who was mentioned previously, as "cured" of his disease after only twenty-five months.

One of four patients with carcinoid tumors died of metastases. This agrees with other studies that record the incidence of malignancy among carcinoids of the small bowel at about 25 per cent [*9,15*]. It should be emphasized that only by demonstrating distant metastases or invasion of adjacent structures can malignant and benign carcinoids be differentiated. The cellular characteristics are microscopically similar.

The lymphosarcoma in this series led to a fatal result eleven months after onset of symptoms. At operation widespread lymph node involvement had been found. Following surgical resection radiation was performed but appeared to have little effect. Postoperative radiation has been advocated, although its efficacy has not been adequately assessed [*7,10*]. Two patients have been reported as cured by radiation only [*10*].

Leiomyosarcoma and malignant carcinoids appear to be slower growing than adenocarcinoma and lymphosarcoma, and the former should thus have a potentially higher rate of cure. Botsford and Seibel [*3*] recorded an average survival of 11.5 months for patients with adenocarcinomas and six months for patients with lymphosarcomas of the small bowel; no leiomyosarcomas were included in their series. Mayo and Nettrour [*11*] reported the average duration of life following operation for adenocarcinoma of the jejunum to be 17.6 months. Warren and Lulenski's [*22*] series indicated a life expectancy of 2.5 years for patients who had solitary lymphoid tumors of the gastrointestinal tract and Burman and van Wyk [*5*] reported that thirteen of twenty-five patients with this neoplasm died in less than one year following onset of the disease. The literature contains little regarding the prognosis of leiomyosarcomas except that they, like carcinoids, are regarded as slow growing lesions [*8*], and patients with this tumor may live from five to ten years with known recurrences.

Tumors of Small Bowel

It is generally agreed that the over-all prognosis for malignant tumors of the small bowel is poor. Permanent cure is rare regardless of the type of neoplasm. This discouraging situation may be attributed to the relatively late diagnosis of tumors involving this tortuous, elongated, redundant portion of the gastrointestinal tract.

SUMMARY

1. A total of thirty-six primary tumors of the small bowel, twelve malignant and twenty-four benign, were treated over a period of thirty-three years. Of these, eighteen were discovered incidentally at autopsy or in surgical specimens extirpated for other lesions, and eighteen produced symptoms leading to their detection.

2. Benign tumors of the small bowel often are asymptomatic, but malignant neoplasms almost always produce symptoms. Gastrointestinal bleeding, abdominal pain or intestinal obstruction are the usual presenting syndromes. Pain is by far, the most common symptom and is usually epigastric, recurrent and crampy. The presence of anemia strongly suggests that the small bowel neoplasm is malignant, as does a palpable abdominal mass.

3. Roentgenologic study undertaken in sixteen patients provided evidence of small bowel derangement in ten instances. The studies performed were plain films of the abdomen, roentgenograms of the stomach and duodenum, small bowel series and barium enema examination.

4. Surgical excision is the preferred treatment for all patients with neoplasms of the small bowel. Excision for malignant lesions should include wide resection of the adjacent mesentery. Radiation also has been suggested for lymphoid tumors.

5. Of twelve patients with malignant small bowel neoplasms only two are known to be free of disease. These patients had leiomyosarcoma and a carcinoid tumor, and are living twenty-five and thirty months, respectively. Both of these are slow growing neoplasms, and the patients cannot be considered cured at this early date.

6. Of the malignant small bowel neoplasms leiomyosarcomas and carcinoid tumors have the longest survival time and adenocarcinomas and lymphosarcomas the shortest.

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Abnormalities of Rotation of the Bowel

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CONGENITAL duodenal obstruction has been the subject of many papers since it was first reported. There are two types of congenital obstruction of the duodenum. One is intrinsic, such as diaphragmatic hernias or atresias, and the other is extrinsic, as seen most frequently with incomplete rotation of the intestine. An evaluation of fifty-seven cases of anomalies in rotation which were treated at the Children's Orthopedic Hospital in Seattle, Washington, from 1939 to 1959 are reported herein.

EMBRYOLOGY

The process by which the primitive gut is converted from a straight tube suspended in a sagittal plane on a common dorsal mesentery to that position seen at birth is called intestinal rotation. Our knowledge of this process dates from the work of Mall [1] in 1898, Frazer and Robbins [2] in 1951, Dott [3] in 1923, and Snyder and Chaffin [4] in 1954.

The section of the primitive intestinal tract from the duodenojejunal junction to the mid-transverse colon is called the midgut. It is this section which is primarily concerned with intestinal rotation.

The rotation of this midgut loop has been conveniently divided into three stages by Frazer and Robbins [2]. During the first stage there is a 90 degree counterclockwise rotation of the midgut, which is within the umbilicus at this time. Failure of retraction of the bowel beyond this stage leaves an omphalocele with retention of the entire midgut and occasionally the liver, spleen, and pancreas, in an umbilical hernia.

The second stage of this process is most important since a failure of completion of this stage causes the largest number of clinical abnormalities. During this period the midgut loop enters the peritoneal cavity. The proximal (prearterial) segment which will become the duodenum and upper jejunum enters the abdomen and passes downward on the right side and then beneath the superior mesenteric vessels. As Snyder and Chaffin [4] have pointed out, the proximal jejunum passes well to the left of the base of the artery. When the upper jejunum reaches its final position, it assumes the shape of one end of a horsehsoe with the pylorus as the other end and the superior mesenteric vessels in the center. This represents a rotation of almost 270 degrees.

The cecum and ascending colon then enter and go above and to the right of the superior mesenteric vessels. Thus, the ascending, transverse and descending colon also assume the shape of a horseshoe with its central portion superior to the vessels and the ends represented by the cecum and the lower descending colon. Both the upper and lower portions of the midgut encircle their common blood supply by an arc of 270 degrees each. They are connected by the remainder of the small bowel.

The final descent of the cecum and the process of attachment of the mesentery is known as the third stage of rotation. As the jejunum and the cecum reach their final positions in the abdomen, their mesenteries normally attach to the posterior abdominal wall. These attachments effectively prevent the subsequent volvulus of the entire midgut. As Snyder and Chaffin [4] have pointed out, the attachment of the jejunum is probably fully as important as that of the cecum in preventing volvulus.

Varying degrees of failure in the second stage of rotation may occur. These may include failure of rotation of the jejunum as well as of the cecum. Indeed the rotation may actually occur in the reverse direction. If failure occurs in the second stage, the stage of attachment of

the mesentery to the posterior abdomen will not have been reached and volvulus is possible.

This study deals primarily with the anomalies found in the first stage (omphalocele) and those of the second stage of embryonic rotation (malrotation). The latter entity includes two clinical aspects. First, there are peritoneal bands from the mobile hepatic flexure or cecum that envelop the duodenum and can produce obstruction. Secondly, and of equal importance, there is inadequate fixation of the mesentery which fans out from the superior mesenteric vessels so that the bowel supplied by these vessels may twist causing a volvulus with its axis being the base of these vessels. Such a volvulus may cause difficulty either by mechanical kinking and obstruction of the bowel or by infarction of the bowel from obstruction of its blood supply, or both.

Since 1932 the surgical treatment of malrotation has been the operation advocated by Ladd [5]. Before this time only fifteen successfully operated cases had been reported in the literature. Essentially, Ladd's operation restores an earlier stage of embryonic development. To accomplish this the duodenum is exposed throughout its course by making an incision in the posterior parietal peritoneum just to the right of the duodenum and by freeing the duodenum from the base of the mesenteric vessels. This allows the cecum and its mesentery to be transferred to the left, releasing the extrinsic pressure on the anterior surface of the duodenum. When a midgut volvulus is found at the operation, the entire midgut must be pulled out on the abdominal wall. The volvulus is then reduced, the peritoneal bands across the duodenum are divided, and the cecum is placed in the left upper quadrant.

ANALYSIS OF CASES

Age. The age incidence in this study varied from the newborn to eleven years of age. (Table 1.) The older children in the series were diagnosed at exploratory laparotomy for recurrent intestinal obstruction. Forty-one (72 per cent) were under two weeks of age, twenty-one of these were diagnosed in the first week of life.

Sex. There is no sex prevalence. Thirty out of the fifty-seven cases in this series were boys.

Signs and Symptoms. These depend on the age and upon whether or not a volvulus is present. Of the total fifty-seven cases, there were ten omphaloceles. The diagnosis of this congenital defect is obvious from physical examination.

TABLE 1
AGE RANGE OF PATIENTS

Age	No. of Patients
Under 1 week	21
1 to 2 weeks	20
2 to 3 weeks	2
3 weeks to 1 year	8
1 year to 4 years	1
4 years to 11 years	5

Of the forty-seven cases of malrotation (anomalies in second stage), there were six which presented symptoms primarily associated with other congenital anomalies such as severe congenital heart disease and congenital diaphragmatic hernia. Other cases of diaphragmatic hernia are reported in the hospital records which very likely included an incomplete rotation.

The remaining forty-one cases presented symptoms primarily concerned with malrotation. (Table II.) Vomiting was recorded as the presenting symptom in twenty-seven. In twenty of these cases the vomitus was bile stained. These children often retained feedings for the first twenty-four to forty-eight hours of life, then vomited several feedings, and then retained feedings again. This finding has also been noted by others [6–8]. In the six children over one year of age, symptoms of intermittent intestinal obstruction had recurred at frequent intervals previously.

On physical examination abdominal distention localized to the upper abdomen was noted in sixteen of the children. Visible waves of gastric peristalsis were an infrequent and inconsist finding (five cases).

Waugh [9] emphasizes the emptiness of the right iliac fossa resulting from the absence of the cecum from its normal position as a helpful physical finding. This was recorded in only one case in our series.

Symptoms from an associated volvulus of the midgut depend on the tightness of the twist and whether or not there is associated vascular occlusion.

Of the forty-one cases of primary malrotation, twenty-three were found to have a volvulus of

TABLE II
SIGNS AND SYMPTOMS WITH OMPHALOCELE* AND MALROTATION†

Signs and Symptoms	No. of Patients
Symptoms of other congenital anomalies	6
Symptoms of malrotation	41
Vomiting	27
Bile stained	20
Intermittent crampy pain	6
Signs	
Abdominal distention	16
Visible peristalsis	6
Empty right lower quadrant	1

* Ten cases.
† Forty-seven cases.

TABLE III
PREOPERATIVE X-RAY FINDINGS

Type of Examination	Results	No. of Patients
Plain film		21
Normal	2	
Upper small bowel obstruction	11	
Lack of small bowel air	8	
Barium enema		9
Cecum in left lower quadrant	5	
Upper gastrointestinal series		11
Normal	4	
Partial obstruction to duodenum	4	
Duodenum and jejunum on right side	3	

all or part of the midgut around the superior mesenteric artery. Five occurred in the intrauterine period or within the first two days after birth.

Preoperative x-ray examinations were obtained in twenty-three of the children. (Table III.) Plain roentgenograms of the abdomen were considered normal in two. Eleven suggested a partial obstruction of the small bowel with a dilated stomach and duodenum. Eight of these cases showed no air in the small bowel. Preoperative barium enemas were performed in nine cases. Five of these showed the cecum to be in the left lower quadrant which confirmed the diagnosis of malrotation. Upper gastrointestinal roentgenograms were taken in eleven cases. Five of these were considered normal. Four showed partial obstruction to the barium in the duodenum. Three showed the entire duodenum and first portion of the jejunum to lie on the right side of the vertebral column.

Although eleven of the cases had upper gastrointestinal roentgenograms, we believe that it is generally unnecessary to use this examination in the younger child since it rarely gives additional information over the plain film and may produce serious complications if an obstruction exists.

It is important that the clinician does not belabor the differential diagnosis and that he realizes that the most important conclusion to be made is whether or not a mechanical bowel obstruction exists. That the diagnosis presents a serious stumbling block to successful treatment is indicated by the fact that in a collected series of forty-two cases under five years of age, 47 per cent remained undiagnosed until autopsy [8].

The incidence of associated congenital anomalies varies with different reports. It is 27 per cent in this series (Table IV). Many of these children have more than one anomaly. The most common ones are cardiovascular. Patent foramen ovale and intraventricular septal defects are the most common types, and associated duodenal atresia or stenosis is often

TABLE IV
ASSOCIATED CONGENITAL ANOMALIES
(27 PER CENT OF CASES)

Type of Anomaly	No. of Patients
Cardiovascular	4
Patent foramen ovale	3
Intraventricular or intra-atrial septal defects	3
Coarctation of aorta	1
Patent ductus arteriosus	1
Tetralogy of Fallot	1
Cor biloculare	4
Duodenal atresia	3
Diaphragmatic hernia	3
Exstrophy of bladder	1
Meckel's diverticulum	1
Duplication of cecum	1
Annular pancreas	1
Imperforate anus	1
Cleft lip and palate	1
Polydactylism	1
Mongolism	1

TABLE V
MORTALITY

Type of Anomaly	No. of Patients	Deaths	
		No.	Per cent
First stage (omphalocele)	10	8	80.0
Second stage (malrotation)	47	10	30.0
Totals	57	22	38.6

present, which is a very serious and important associated anomaly since it can be missed at the original operative procedure. There were three of the fifty-seven patients in this series who had associated intrinsic duodenal obstruction. Gourevitch [*10*] found five of thirty-one patients who had associated intrinsic duodenal obstruction from stenosis or atresia. Another common associated congenital anomaly is diaphragmatic hernia. There were three known cases in our series and probably more in which the malrotation is clinically silent.

MATERIAL

A total of fifty-seven cases of anomalies in rotation of the intestine have been seen at the Children's Orthopedic Hospital during the period of 1939 to 1959. The over-all mortality of these cases was 38.6 per cent (twenty-two deaths). (Table v.)

Anomalies of the First Stage of Rotation. Ten cases were found to be arrests in the first stage of rotation (omphalocele). Of these ten children, three were moribund from perforated omphaloceles when first seen (one died without surgical repair, two died in the immediate postoperative period). Five of the remaining seven died in the immediate postoperative period, three from associated congenital heart disease and two from postoperative peritonitis.

Anomalies of the Second Stage of Rotation. All the forty-seven cases of malrotation were operated upon except two who were diagnosed by roentgenogram. One of these died from severe respiratory difficulty secondary to pulmonary atelectasis prior to surgery, and one died from congenital heart disease prior to operation. Of those forty-five patients who were operated upon, the Ladd procedure or a modification of this was used. There were fourteen deaths in this group (Table VI). Ten

TABLE VI
MORTALITY FROM ANOMALIES IN SECOND STAGE OF ROTATION*

Cause of Death	No. of Patients
Immediate postoperative period	
Peritonitis from perforated viscus	5
Congenital heart disease	2
Diaphragmatic hernia	2
Pulmonary atelectasis	1
Immediate postoperative period	
Recurrent volvulus	2
Air embolism	1
Bowel obstruction	1

* Statistics among forty-five patients operated (Ladd procedure).

died in the immediate postoperative period, five from peritonitis, two from congenital heart disease, two from respiratory difficulty associated with repair of an associated congenital diaphragmatic hernia, and one from pulmonary atelectasis.

Of the children who survived after the immediate postoperative period, two have died of recurrent volvulus, one died five days following surgery, and the other died one year after surgery. Another patient died nine days postoperatively from air embolism while he was receiving a blood transfusion, and one died at home two months after his operation from intestinal obstruction secondary to adhesions.

We have been able to follow up thirty of these children since their original surgery. (Table VII.) Two have had postoperative bowel obstruction from adhesions, one died as noted previously. Four have symptoms suggesting adhesions but

TABLE VII
POSTOPERATIVE FOLLOW UP

Symptoms	No. of Patients
Bowel obstruction	2
Symptoms suggesting partial obstruction	4
Constipation	5
Volvulus (recurrent)	3
Hypertrophic pyloric stenosis	3
None	13
Total	30

have not required further surgery. Constipation has been a persistent problem in five. There have been three recurrent volvuli. Two of these patients died of the volvulus, and the third occurred twenty-four days postoperatively and was relieved by surgery. Three children developed hypertrophic pyloric stenosis which was relieved by surgery. Finally, thirteen have had no difficulty whatsoever, and their parents report that they are completely normal.

DISCUSSION

Several important observations can be made from the study of these cases. The process of return of the midgut to the abdomen and its rotation to the final adult position may become arrested at any stage. The most common variation seen is that in which the cecum has failed to rotate to the right lower quadrant. In addition, the jejunum will have failed to rotate and to attach on the left side of the abdomen. The close entrapment of the duodenum in the stalk of the superior mesenteric vessels or its blockage by bands from the cecum may cause obstruction of its lumen. The inadequate fixation of the mesentery which is associated with this condition encourages formation of volvuli with kinking of the bowel or the blood vessels, or both.

When bowel obstruction or a volvulus occurs, early operation is the treatment of choice. The fact that three volvuli occurred after the conventional Ladd procedure is of particular importance. It is difficult to ascertain the reason why a recurrent volvulus developed in these patients. However, it seems reasonable to assume that the tendency to redevelop a volvulus in the postoperative period would be high since the entire midgut remains suspended on a narrow pedicle around the superior mesenteric artery. Recurrences have been reported by others in cases where adhesions between loops of bowel in the volvulus or adhesive bands crossing the duodenum were not divided [*11–14*].

The over-all mortality in these cases is high, being 38.6 per cent. Gardner and Hart [*9*] reviewed 103 cases of anomalies in intestinal rotation in the literature in 1934 and added two of their own. They noted that the over-all mortality was 58 per cent. When the cases in this series of associated severe congenital anomalies and those who were moribund from generalized peritonitis secondary to perforated viscus are excluded, the mortality in our series drops to a considerably lower level (17 per cent). This compares favorably with other reports in the literature which range from 11.1 per cent [*15*], 23 per cent [*16*], to 33.3 per cent [*14*].

We have obtained adequate follow up in thirty of our cases. It seems significant to us that five (16.6 per cent of these children have had persistent difficulty with constipation requiring frequent enemas and careful diet regulation. Also, three (10 per cent) have subsequently developed hypertrophic pyloric stenosis. We are unable to explain either of these symptoms and have found no note in the literature of these problems in other follow-up studies.

SUMMARY

1. Fifty-seven cases of malrotation which are in the records of the Children's Orthopedic Hospital in Seattle, Washington are presented.

2. The embryology and pathology of malrotation is discussed.

3. Vomiting bile-stained material dating from birth, or soon after, is the most frequent symptom.

4. Associated congenital anomalies were present in 27 per cent of our cases, the most common being those of the cardiovascular system.

5. Recurrent volvulus after the conventional Ladd operation is an important postoperative complication (7 per cent).

6. Constipation is a persistent complaint in 16 per cent of the thirty cases followed from six months to seventeen years.

7. The over-all mortality in this series is high, being 35.6 per cent. When deaths from other congenital abnormalities and from cases which were moribund on admission are excluded, the mortality becomes 17 per cent.

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Our Surgical Heritage

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UNITED STATES OF AMERICA

WILLARD PARKER

WILLARD PARKER, who introduced clinical lectures into medical school teaching, was born at Lindborough, New Hampshire on September 2, 1800. He spent his early life in Chelmsford, Massachusetts. He taught school in order to gain money for an education. He entered Harvard University and graduated with the class of 1826. While a student in Boston, he had the good fortune of seeing Dr. John Collins Warren treat a patient with a strangulated hernia. It is said that this stimulated him to study medicine. He received his M.D. degree from Harvard Medical School in

1830 and was an intern at the Marine Hospital in Chelsea. He became a teacher of surgery in a new medical school at Windsor, Vermont in 1831 and later was appointed professor of anatomy in the Berkshire Medical School at Pittsfield, Massachusetts. It was here that he met Alonzo Clark, Elisha Bartlett and Robert Watts who later became professors in the College of Physicians and Surgeons in New York City. He spent the year 1836 in Cincinnati as professor of anatomy. After this he studied abroad and became professor of surgery at the College of Physicians and Surgeons in New York City in the latter part of 1837. He was head of the department in this school until 1859. With the assistance of James R. Wood he converted the almshouse at Bellevue into a hospital and was an attending surgeon in this institution. He was appointed attending surgeon to New York Hospital in 1850 and later was on the staffs of St. Luke's, Roosevelt and Mount Sinai Hospitals.

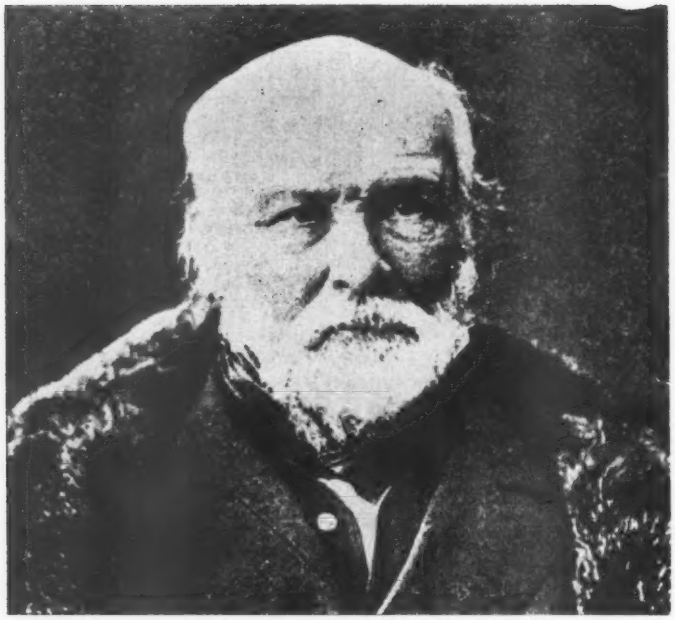
He was the first to do a cystotomy in 1850, and it has been said that he was the first in this country to lead the way for the proper treatment of appendicitis (1864) not knowing that Hancock in London had also performed a successful appendectomy (1848). Parker collected a library of about four thousand volumes and at his death it became a part of the library of the Medical Society of the County of Queens, Brooklyn, New York. Willard Parker was instrumental in the erection of the hospital for infectious diseases in New York City which was named after him, The Willard Parker Hospital.

In 1870 Princeton University conferred upon him the honorary degree of Doctor of Law.

He was probably one of the most successful operating surgeons in New York during his lifetime.

Willard Parker saw patients in consultation up to the last day of his life when he was stricken with a cerebral hemorrhage and died in New York City on April 2, 1884.

EUROPE.



NIKOLAI IVANOVICH PIROGOFF

Nikolai Ivanovich Pirogoff for whom the Pirogoff amputation at the ankle joint is named, was born in Russia in 1810.

He received his degree (Doctor of Medicine) in 1832 and boldly defended his graduation thesis, "Treatment of Aneurism of the Iliac Artery," in which he promulgated the theory that the solution of many clinical problems requires not only clinical observation but also experimentation with animals.

Pirogoff concluded by experimentation that ligation of a bleeding artery can only be practicable when its inner and middle coats are divided, thus curling within the artery.

He studied for two years in Germany. Pirogoff believed that Langenbeck was the best informed German surgeon.

He taught for five years at Dorpat, Russia and was appointed professor of surgery at the Medico-Chirurgical Academy at St. Petersburg in 1840.

Pirogoff referred to war as a "traumatic epidemic" after the Crimean War (1854).

In 1847 Pirogoff first used ether anesthesia and advocated and instilled ether into the rectum for anesthesia. He is best remembered for his osteoplastic amputation of the foot (1854), and his "Treatise on Military Surgery" (1864).

Pirogoff exhibited speed, dexterity and firmness of hand as an operating surgeon. Like many Slavic virtuosos in music he was amazing.

Nikolai Ivanovich Pirogoff died in 1881. "His large nature was filled with the love of justice but he was also of the stuff of which glories are made."

Surgery Court Cases

HOWARD NEWCOMB MORSE,* *Atlanta, Georgia*

MARSH VS. PEMBERTON

Supreme Court of Utah

10 Utah 2d 40, 347 P. 2d 1108

The patient, a married man twenty-three years of age, had injured his left foot and undergone surgery several years prior to his first consultation with the surgeon in this case. The surgeon had twenty-nine years of experience in the practice of medicine, of which twenty-one years had been devoted to the specialty of orthopedic surgery.

After taking roentgenograms of the patient's foot, the surgeon advised him that an operation would be necessary to restore the normal use of his foot without accompanying pain. The operation performed was a triple arthrodesis which required an incision on the upper surface of the foot and exposure of the bones of three joints in the foot.

The ends of the bones comprising the joints were exposed, cartilage was removed and bone surfaces were excised. Then the foot was placed in a new position, the bones were fitted together with the expectation that the surfaces would heal and fuse to make one solid joint. With the foot in its corrected position, a long cast was applied to the leg, gripping the foot so that the ends of the bones would not be allowed to move or shift even slightly from the proper position for healing.

When the patient regained consciousness after operation, he experienced pain and some swelling of his foot. On the following day the toes became numb and slightly discolored. At 8 A.M. on the second day, approximately forty-five hours after the operation the surgeon thought it necessary to split the cast in order to allow more adequate circulation because of the increased discoloration and numbness of the patient's toes.

The next day the foot was still swollen and discolored but the surgeon noted on the hospital chart that the motor function was good and circulation adequate. However, the patient still had no sensation in his toes. He left the hospital later on crutches and returned to the surgeon's office four or five times at intervals of about two weeks to have the cast changed. On the second of such visits the foot was still dark in color and the wound had not healed. There also appeared to be a draining of pus and an accompanying bad odor.

The surgeon was asked but would not explain why the foot did not improve or the causes of the bad odor and continued pain. The patient was on crutches for six months, although he was originally expected to be on them for only three months.

It was discovered sometime later that one of the three joints (the cuboid) had failed to fuse. Roentgenograms indicated that the cuboid dropped about an eighth of an inch toward the bottom of the foot. The patient said that when he began to walk it felt as though he were walking on a marble. An open sore developed on the bottom of the patient's foot and his toes also became clawed, rubbed on his shoe and became sore.

The patient visited another surgeon to determine what measures could be taken to relieve the sore on the bottom of his foot. The second doctor performed surgery and cut off part of the prominence of the underlying bone.

The patient brought an action in the Third District Court of Salt Lake County, Utah, against the first surgeon to recover damages for alleged malpractice and negligence. Evidence received at the trial indicated that a successful triple arthrodesis leaves the foot approximately 20 per cent disabled, but the patient's

* Counsellor at Law of the Supreme Court of the United States of America.

foot was between 25 per cent and 30 per cent disabled. The patient did not offer any testimony of an independent medical expert to establish the general standard of orthopedic surgeons or the proper procedure for casting a triple arthrodesis in the Salt Lake City locality. The court rendered judgment in favor of the surgeon, and the patient appealed.

The Supreme Court of Utah affirmed the decision of the court below. The Supreme Court upheld that the standard of care required by a surgeon for the casting procedure and postoperative care of a triple arthrodesis operation must be established by expert medical testimony.

DONALDSON VS. MAFFUCCI

Supreme Court of Pennsylvania

397 Pa. St. 584, 156 A. 2d 835

The patient was injured in an automobile accident in the late evening and was admitted to the Bedford County Memorial Hospital in the early morning of the following day. The surgeon, the patient's private physician, was summoned. When the doctor arrived at the hospital, he ordered roentgenographic examination of the patient's left wrist and jaw.

The examination indicated a Colles' fracture of the left wrist consisting of a fracture of the distal radial metaphysis with marked posterior and lateral displacement of the distal fragment which was rotated posteriorly and overrode the proximal fragment for about 1 cm. There was also a fracture of the ulnar styloid. The patient's upper lip was lacerated (2 by 2½ inches).

She was anesthetized, and the surgeon performed a closed reduction of the fractured wrist, sutured the lip, directed another x-ray examination and applied a cast to the left arm from the elbow down to the tips of the fingers. Later on the same morning the surgeon removed the cast and manipulated the fracture, without anesthesia.

An x-ray examination made at that time indicated correction of overriding of the bones. It also showed that there was "about 5 mm. posterior displacement of the distal fragment . . . now rotated posteriorly for only 15 degrees" and that the position was improved over that shown in the previous x-ray film. The cast was then reapplied.

A second surgeon (the senior surgeon of the hospital) was called into consultation by the first surgeon. The second surgeon recommended an open reduction, which was never performed. Another x-ray examination was made which indicated that the improvement of position obtained by the second closed reduction had been lost. This examination was not interpreted for for the surgeon until after the patient had left the hospital.

At the time the patient left the hospital her left arm was enclosed in a cast from the elbow to the tips of her fingers. The surgeon did not treat the patient subsequently.

She consulted another surgeon (a third surgeon), who found some deformity in the wrist and some stiffness in the finger joints. The patient was readmitted to the hospital where a further examination by roentgenograms and fluoroscopy revealed the existence of the same conditions as noted in the last previous x-ray examination. The third surgeon then attempted another closed reduction.

The patient left the hospital and remained under the third surgeon's care. Later she was readmitted to the hospital. It had been discovered that, despite the third surgeon's attempt at a closed reduction, a nonunion of the bones existed. While at the hospital, two open reductions were performed by the third surgeon which included the insertion first of wires, then (later) of a bone plate. At a subsequent time, at the third surgeon's suggestion, the patient consulted a fourth surgeon in Pittsburgh who performed further operations on the wrist.

The patient and her husband filed an action in the Court of Common Pleas of Bedford County, Pennsylvania, against the surgeon (the first surgeon) to recover damages for injury resulting from alleged malpractice. At the trial the patient and her husband failed to produce expert witnesses whose testimony would support their claim and who would conclude that, in their professional opinion, the patient's injury resulted from the surgeon's negligence. The court dismissed the case, and the patient and her husband appealed.

The Supreme Court of Pennsylvania sustained the decision of the lower court. The Supreme Court ruled that expert testimony in support of the patient's claim that the surgeon was negligent in the reduction of her wrist fracture was necessary to establish her right of action for malpractice.

BOOK REVIEWS

Mitral Valvulotomy. By Harold J. Stewart, M.D. and Frank Glenn, M.D. 244 pages. Charles C Thomas. Springfield, 1959. *$10.50.*

This is an excellent long term review of patients who have undergone mitral valvulotomy. The various facets of the problem are treated with detail and frequently case illustrations are used to emphasize important points. In the authors' series of patients, who were followed up for an average of fifty months postoperatively, there was a late mortality of 23 per cent. Of those patients surviving, the results were good in 80 per cent.

HOWARD D. SIRAK, M.D.

Treatment of Lung Cavities and Endobronchial Tuberculosis (with Special Reference to Treatment in Malaya). By Beryl E. Barsby, M.D., M.R.C.P. 147 pages. Williams & Wilkins Co. Baltimore, 1959. *$4.75.*

Dr. Barsby has produced an interesting account of the problems of pulmonary tuberculosis in Malaya. To this has been added a diligent review of the literature pertaining to endobronchial tuberculosis, the relation of this lesion to the diseased parenchyma, and the modern concepts of drug therapy of tuberculosis. Against this background and study, the author presents her interpretation of 1,121 bronchoscopic studies utilizing both gross appearance and histologic examination of biopsy material to classify endobronchial tuberculosis into six grades and to relate these to the clinical characteristics of the pulmonary disease.

The other contributors to this book amplify the basic material by delineating the problems of epidemiology, anesthesia, surgery and physiotherapy in the hospital and community in Malaya where this investigation was conducted.

NEIL C. ANDREWS, M.D.

Cancer, Volume 4. Part VIII: Clinical Aspects of Malignant Tumors. Edited by Ronald W. Raven, O.B.E. (Mil.), T.D., F.R.C.S. 532 pages. Butterworth & Company, Ltd. London, 1958.

Clinical aspects of pre-cancerous and cancerous conditions for all areas of the body are covered in this volume. Historical background plus pertinent references usually introduce a chapter. Short, concise sections on symptoms, diagnosis, treatment methods, complications and end results make this book a relatively quick and complete reference.

The first chapter deals with staging of cancer, including the new TNM system recently adopted by the World Health Organization for clinical staging of cancer of the breast.

The various authors' preferences of treatment are usually presented and discussed. The section on the gastrointestinal tract is exceptionally good—being complete, up to date and interestingly written. Experiences with primary and secondary surgical technics for cancer of the liver and its management are particularly timely.

This volume includes a wealth of information which is organized for easy reading and accessibility, and therefore will serve a useful function in any general or surgical practitioner's library.

RICHARD C. MCPHERSON, M.D.

Surgical Forum, Volume 9. 44th Clinical Congress (1958), American College of Surgeons (Proceedings of The Forum Sessions). 866 pages. American College of Surgeons. Chicago, 1959.

The ninth volume of the Surgical Forum is an impressive compendium of 230 papers written by 576 authors. The papers, dealing with basic problems in general and special surgery, are logically divided into fifteen appropriate sections and constituted the Forum on Fundamental Surgical Problems of the 1958 Clinical Congress of the American College of Surgeons.

This highly selective cross section of pertinent and significant surgical contributions is an invaluable and unique reference source for those interested in investigative and academic surgery, as well as the clinician. The majority of the subject material is of such general interest to all surgeons that it transcends the various specialty barriers. For sheer magnitude of current fundamental surgical information, there is no other comparable publication.

LUTHER M. KEITH, JR., M.D.

The Practical Evaluation of Surgical Heart Disease. Written and compiled by Robert G. Trout, M.D. Edited by Robert P. Glover, M.D. 132 pages. McGraw-Hill Book Co. New York, 1959. *$10.00.*

This book, in a very concise fashion, presents the basic clinical aspects of the common congenital and acquired heart lesions. The presentation and content would be particularly attractive to medical students, interns and persons concerned with this field of surgery. However, a more thorough discussion of the basic underlying physiology would be particularly desirable for those whose special interest is heart surgery. A complete understanding of the pathophysiology in each of the defects is essential to the newer therapeutic developments in this field. The section dealing with the surgery of coronary artery disease would best be omitted. The merit of these operations is at best a controversial subject and should not be presented in the same light along with the other operations whose merit has already been established.

HOWARD D. SIRAK, M.D.

Surgical Service Guide. By Louis T. Palumbo, M.D., M.S., F.A.C.S. 208 pages. Year Book Publishers, Inc. Chicago, 1959.

Dr. Palumbo has performed the formidable task of condensing a massive amount of information useful to the surgical service staff. The bulk of this manual is concerned with basic pre- and postoperative orders for many common surgical procedures including emergency cases. The section on trauma is particularly well covered. Orders are based upon the experiences of Dr. Palumbo and his staff and may vary at different institutions. Most problems are basically well covered, although the paragraphs on the management of gastrointestinal hemorrhage are not well outlined.

There are also sections on anesthesia, diagnostic procedures, complications, fluid and electrolytes, and dietetics. There is much useful information in these compact chapters.

This guide should be helpful to the surgical house staff and nurses, particularly if their institution lacks a "precedent book."

D. E. WAGNER, M.D.

Textbook of Oral Surgery. Edited by Gustav O. Kruger, D.D.S. 573 pages. C. V. Mosby Co. St. Louis, 1959. *$12.75.*

Recognized authorities in the field of oral surgery have contributed twenty chapters to this text. The first purpose of the volume is to present a concise description of current thinking in each of the areas of oral surgery. It exceeds other books on the subject in the clear explanation of diagnosis and treatment planning; the basic principles of surgery; new ideas in all areas of major oral surgery; discussion of acquired and developmental deformities and functional and neurologic disturbances of the jaws; and bacteriology of oral infection.

The second purpose is to present the subject of oral surgery to senior dental students. The art and science of removal of teeth has been omitted purposefully from the material since the editor believes all schools have their own teaching methods for these technics.

I believe the material in the text, while accurately and clearly put forth, is quite advanced for dental students. On the other hand, it fulfills requirements needed for postgraduate reading in oral surgery and should be required for all dental interns and for all graduate and postgraduate trainees in oral surgery. It is an excellent reference for all dentists in practice.

MORGAN L. ALLISON, D.D.S.

The Year Book of Cancer, 1958–1959. Edited by Randolph L. Clark, Jr., M.D. and Russell W. Cumley, PH.D. 570 pages. The Year Book Publishers, Inc. Chicago, 1959. *$8.00.*

From the hundreds of articles published over the past year, the competent editors and editorial board of this annual publication have attempted to select the most pertinent and enlightening papers on cancer. The material, divided into concise categories, presents the current advances in therapy, concepts and new research problems pertaining to various types of cancer. The book is divided into sections of anatomic locations, chemotherapies, radiation, treatment of the terminal patient, research, and the pathology and chemistry of cancer. Although data is by necessity condensed, details and meaning are clear and the short editorial comments following many of the articles easily clarify questionable points. For example, reviews on melanoma competently cover the value of radiation, treatment with chemotherapy and the statistical data on surgery.

This book is directed primarily to the physician who cannot read every journal. Easy to digest, it is clear in thought and fair in selection.

FOSTER MARSHALL, M.D.